VECTOR DRAWING

This slideshow is designed to help you understand the very basics of vector graphics and using them to draw shapes. Knowing how to draw on a computer is a very useful skill and it is very important for those who want to design graphics for posters, websites, and In the case of the LCC Fab Lab, to design objects for digital fabrication.

RASTER GRAPHICS or BITMAP IMAGES

Before we go into vectors. Lets discuss the other kind of computer image you may be more familiar with. When you make a poster for a class or when you manipulate a digital photo for a website you are usually working with what is called **RASTER GRAPHICS** also known as **BITMAP IMAGES**. This basically means you are manipulating pixels. Every image on a screen or in a print is made up of a fine grid of **pixels** (screen) or **dots** (physical print). The more pixels or dots the more detail you can achieve but also the bigger the file size.

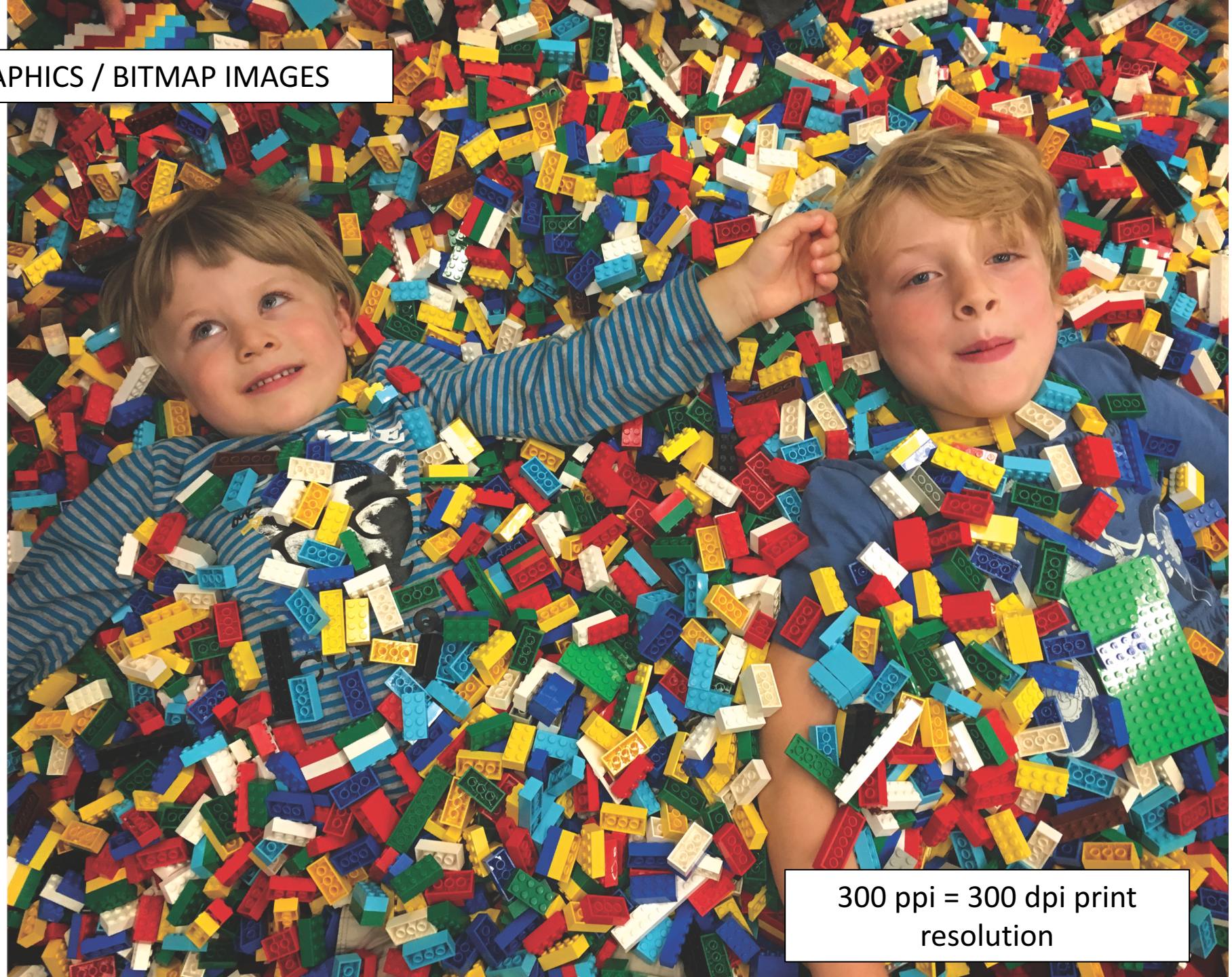
DPI = Dots Per Inch (printing resolution – think of dots of ink)
PPI = Pixels Per Inch (screen resolution – think of pixels on a screen)

Here is a useful article to understand the difference between the DPI & PPI:
https://99designs.ca/blog/tips/ppi-vs-dpi-whats-the-difference/

Learn more about raster graphics:
Raster Graphics Wiki

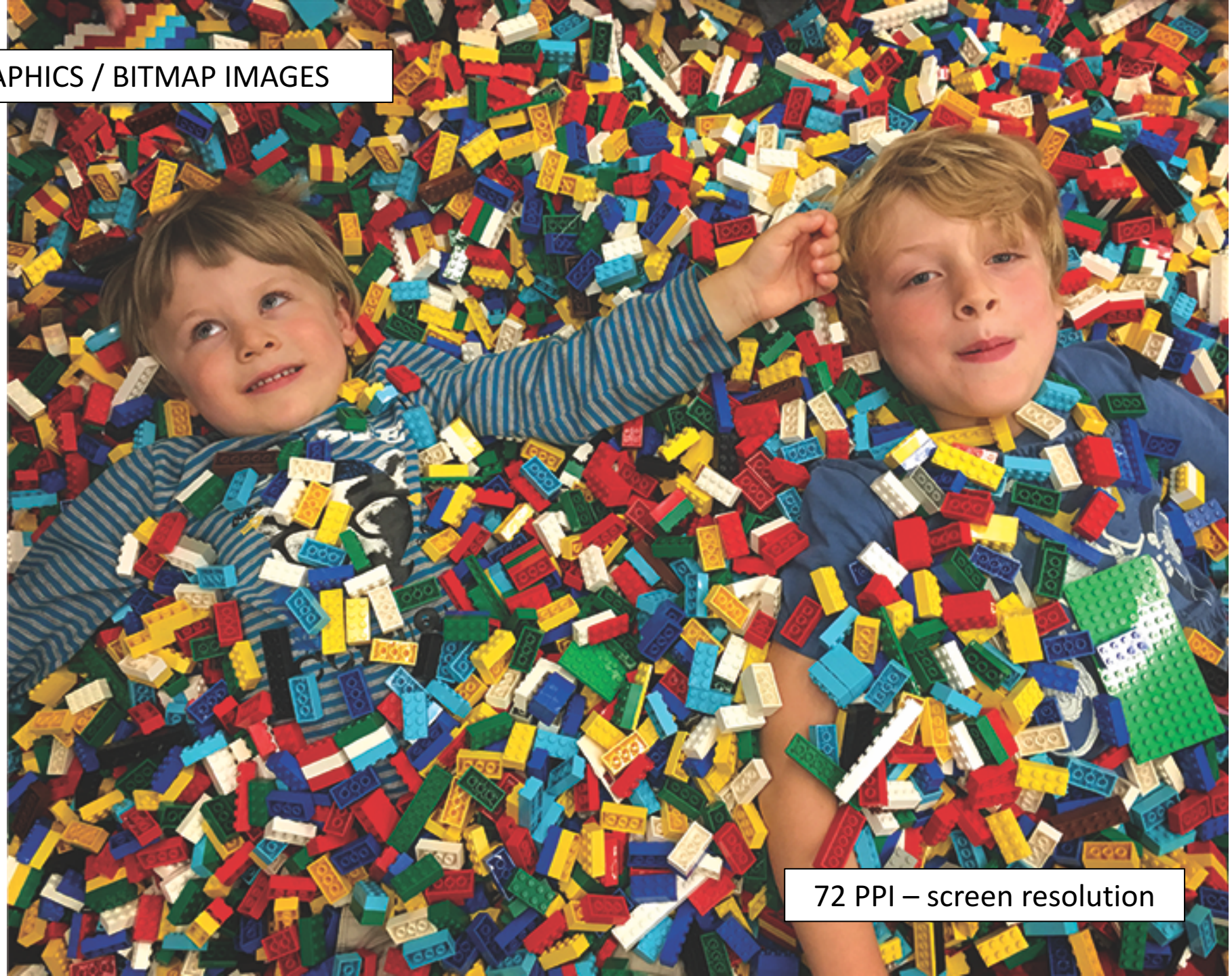
THE NEXT 2 IMAGES ARE THE SAME EXCEPT
DIFFERENT RESOLUTIONS

RASTER GRAPHICS / BITMAP IMAGES



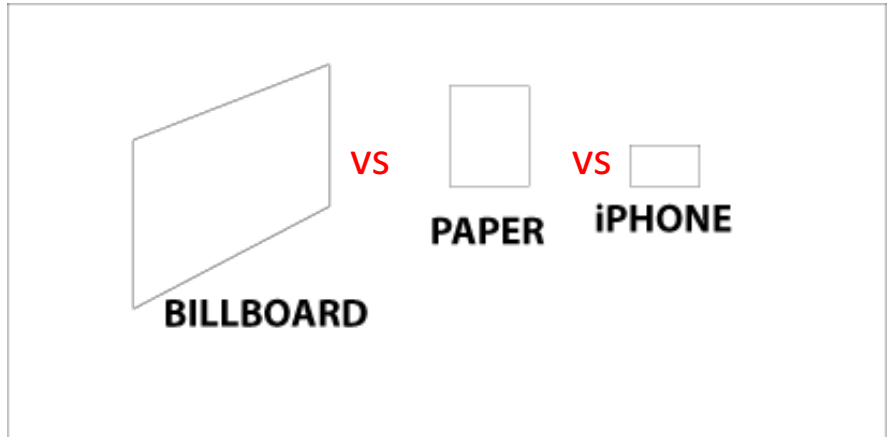
300 ppi = 300 dpi print resolution

RASTER GRAPHICS / BITMAP IMAGES



72 PPI – screen resolution

RASTER GRAPHICS / BITMAP IMAGES



Depending on the screen you are looking on the previous 2 images look like they are almost the same. If you look carefully you will see a difference in sharpness but it would be hard to notice without the comparison. To achieve clear images on a screen the eye only requires 72-96 ppi (pixels per inch). For clear images in a printed photograph, the ideal resolution is generally 300 dpi (dots per inch).

IMPORTANT: This is a generalized description. Resolutions are a lot more complex. The ideal resolution takes into account the **medium** (what the image is presented on), the **size**, and the viewing **distance and angle**. Choosing the right image resolution to work with depends on your intended purpose and the actual size of the file you hope to achieve.

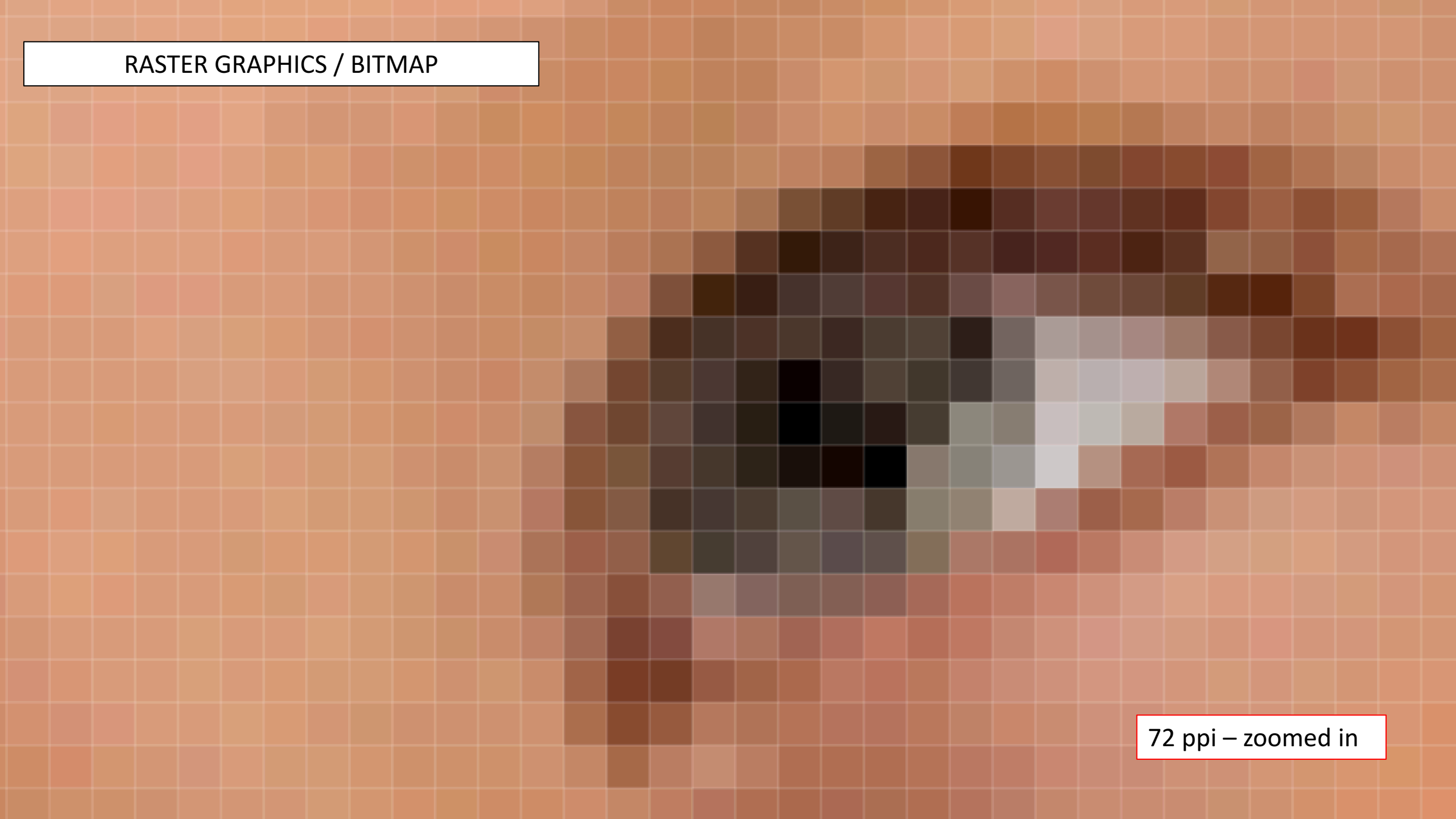
With bitmap images or raster graphics you are stuck with the resolution that you choose. Therefore, when working with bitmaps you want to start with a high enough resolution for the job you are intending.

LET'S LOOK AT THE DETAILS OF THE PHOTOS WE JUST SAW.

RASTER GRAPHICS / BITMAP

300 ppi – zoomed in

RASTER GRAPHICS / BITMAP



72 ppi – zoomed in

2 EXAMPLES OF POPULAR RASTER (BITMAP) DRAWING TOOLS

Used to manipulate raster (bitmap) images and digital photography.

Adobe Photoshop CC

- PC / MAC
- $$ / subscription based
- Very powerful and popular.
- Extension: **.psd**

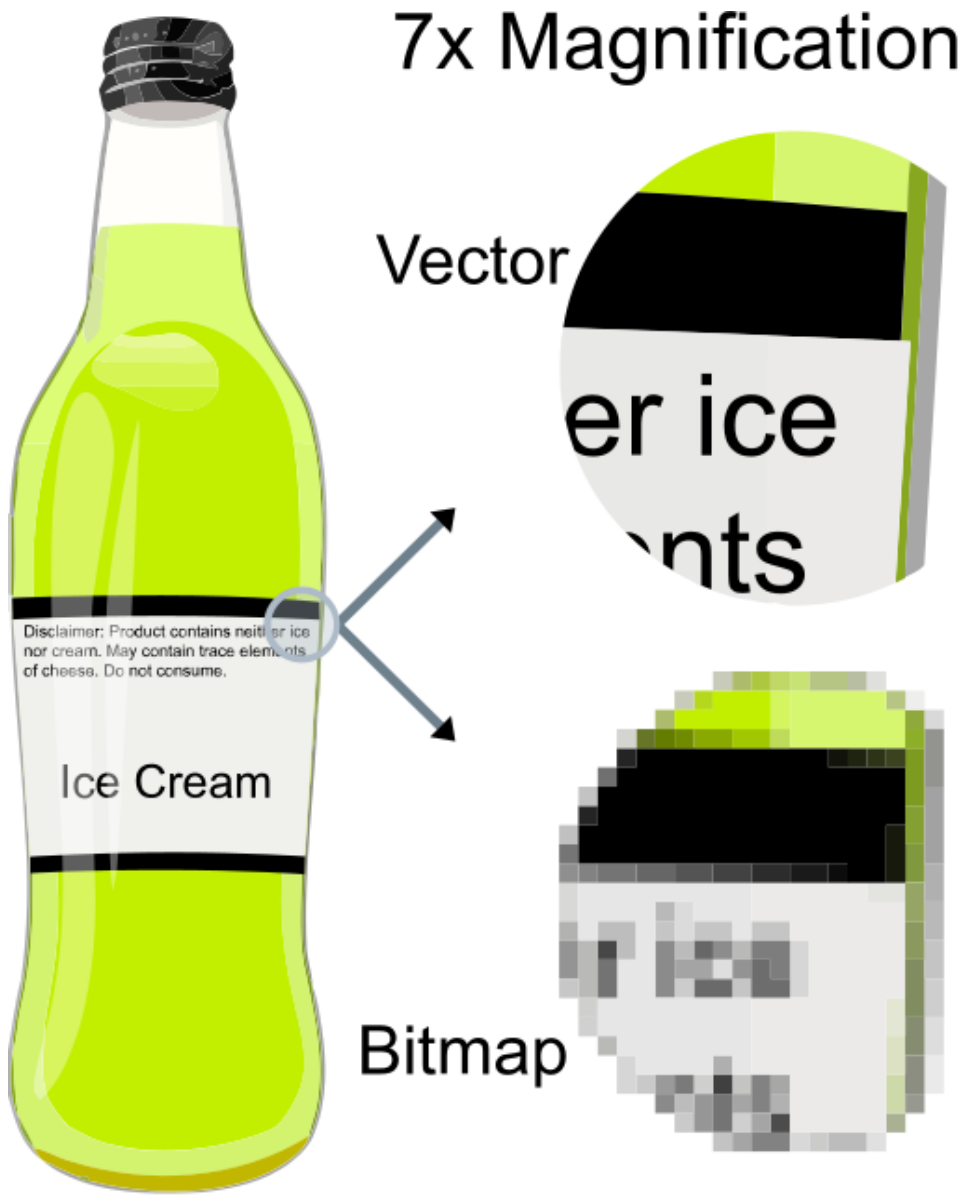
GIMP

- PC / Mac
- Free / open source
- Powerful but less common.
- Extension: **.xcf**

VECTOR GRAPHICS

For more information visit the wiki here:

Vector Graphics



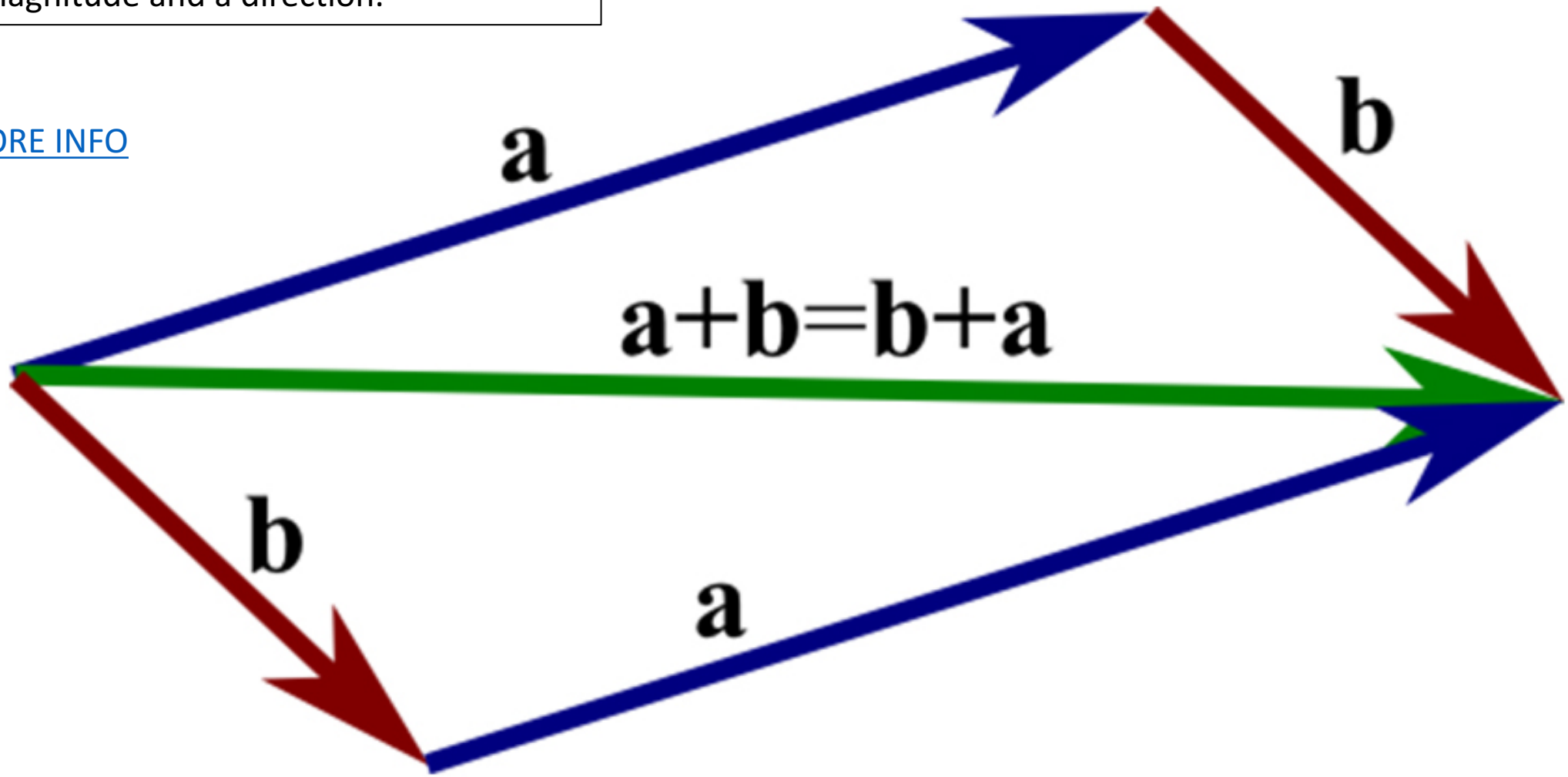
Vectors graphics are scalable: The quality a vector graphic remains no matter what size.

Bitmap Graphics are **NOT** Scalable: The quality a bitmap is locked to the resolution of of the original file.

http://www.wikihow.com/Understand-Vector-Graphics

A vector is a mathematical entity that has a magnitude and a direction.

MORE INFO



Example of code to draw vectors in a PDF.

```
doc.moveTo(0, 20)                                  # set the current point
   .lineTo(100, 160)                               # draw a line
   .quadraticCurveTo(130, 200, 150, 120)           # draw a quadratic curve
   .bezierCurveTo(190, -40, 200, 200, 300, 150)    # draw a bezier curve
   .lineTo(400, 90)                                # draw another line
   .stroke()                                       # stroke the path
```

http://pdfkit.org/docs/vector.html

SVG

SCALABLE VECTOR GRAPHIC

When you want to share your vector drawings with other tools … **“Save As”** or **“Export As” SVG**.

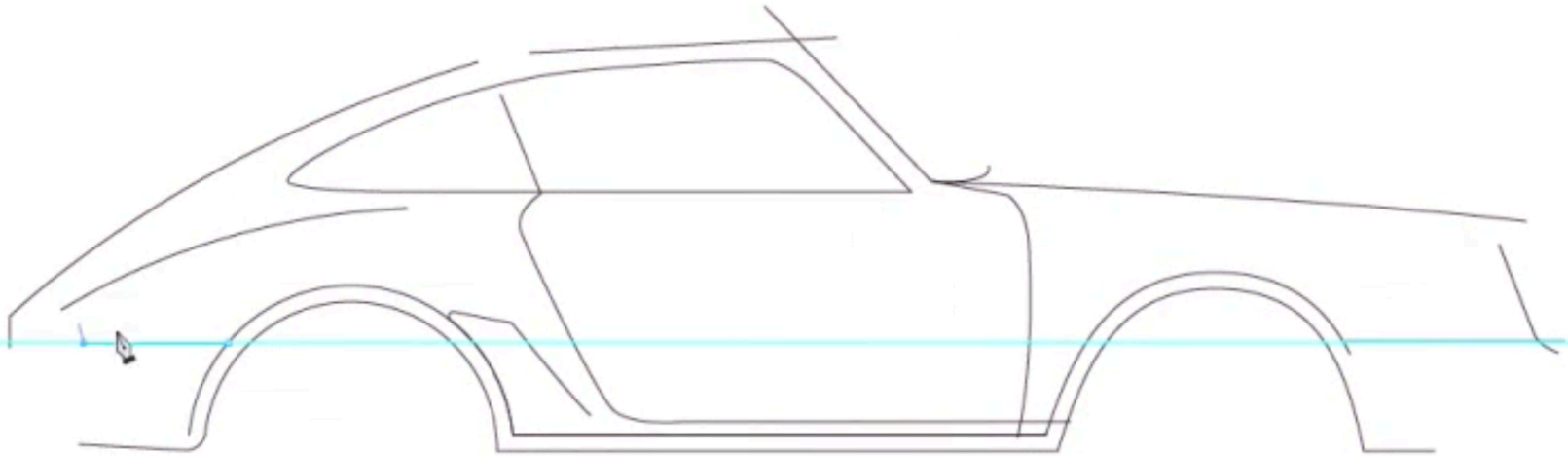
Your file should have **.svg** at the end of it. This is called a “file extension”. Other file extensions you might be familiar with are: *.jpg, .doc, .pdf, .png, .gvdesign, .ai, .psd, .gif.* They refer to the format of your document.

Vector graphics often demonstrate definition in the quality of the lines. Crisp colors and defined paths.

Vector graphics are used to make logos.

LOGOS ARE DESIGNED WITH VECTOR DRAWING TOOLS.

YOU CAN USE VECTOR DESIGN TOOLS TO MAKE PHOTO REALISTIC PAINTINGS AS WELL AS TECHNICAL DRAWINGS



WATCH: Timelapse Illustrator Drawing

4 EXAMPLES OF POPULAR VECTOR DRAWING TOOLS

Adobe Illustrator CC

- Mac / PC only.
- $$ / subscription based
- Very powerful and popular.
- Extension: **.ai**

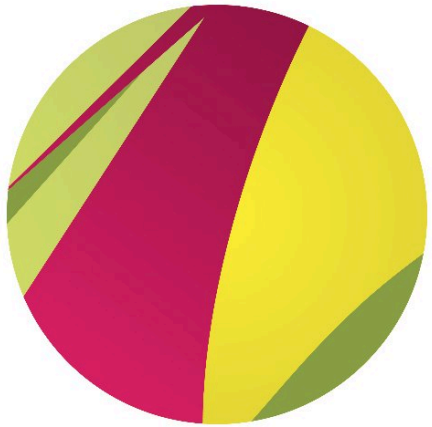
Corel Draw

- PC only.
- $$ / one time license
- Very powerful and popular
- Extension: **.cdr**

CorelDRAW® Graphics Suite X8

Inkscape

- PC / Mac (w/xCode)
- Free / open source
- Very powerful
- Less user friendly
- Extension: **.svg**



Gravit Designer

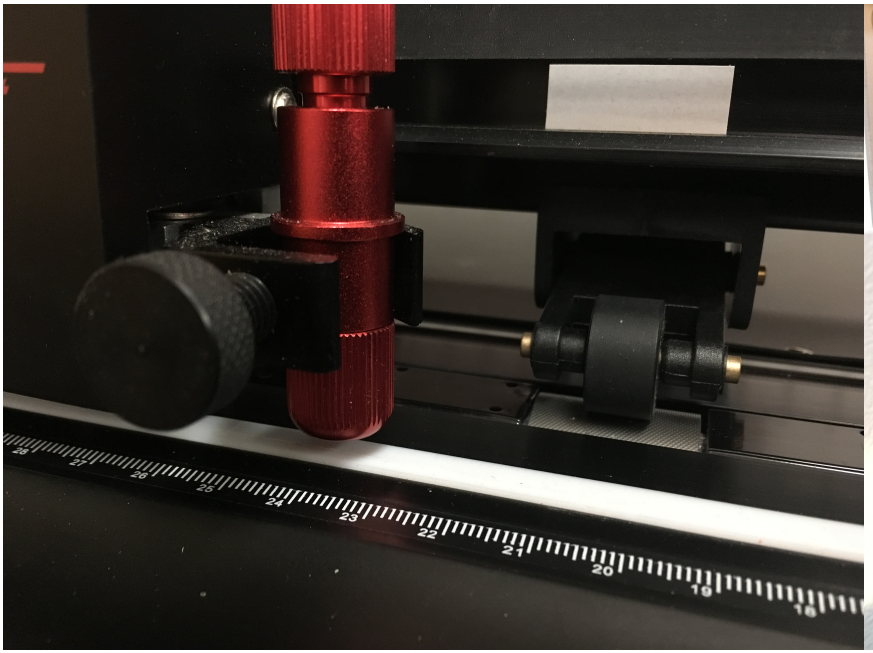
- PC / Mac
- Free
- Powerful enough for most tasks
- Less common / new
- Extension: **.gvdesign**

MACHINES & VECTORS

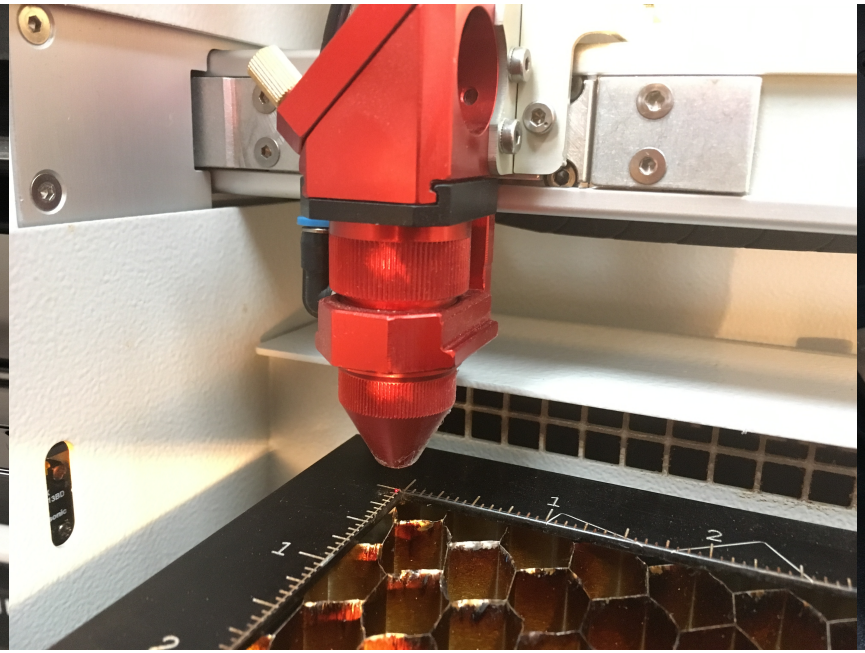
We can use vector drawings to make designs that will be processed by machines. Vectors paths & tool paths used by CNC (*computer numerically controlled*) machines both follow path.

3 EXAMPLES OF CNC MACHINES THAT INTERPRET VECTOR PATHS.

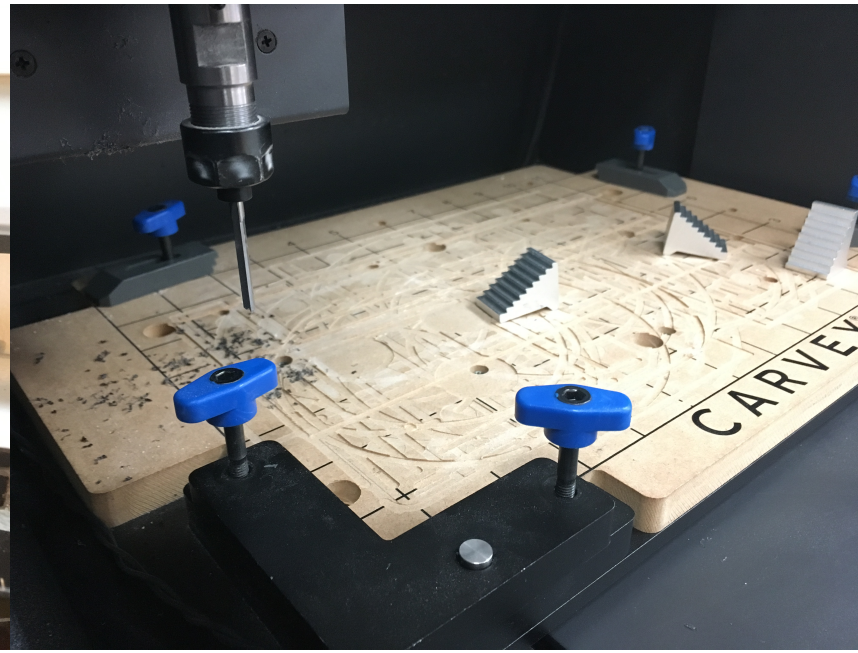
Vinyl Cutter



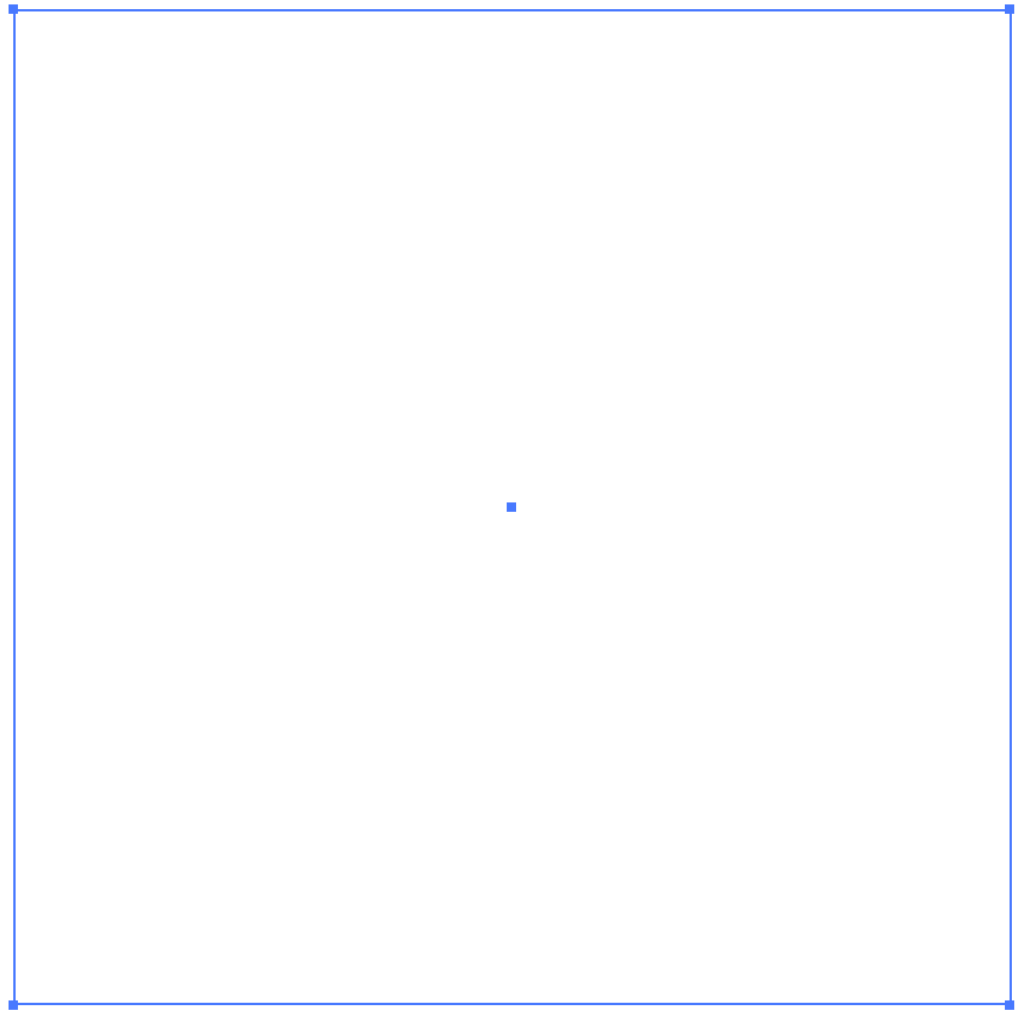
Laser Cutter



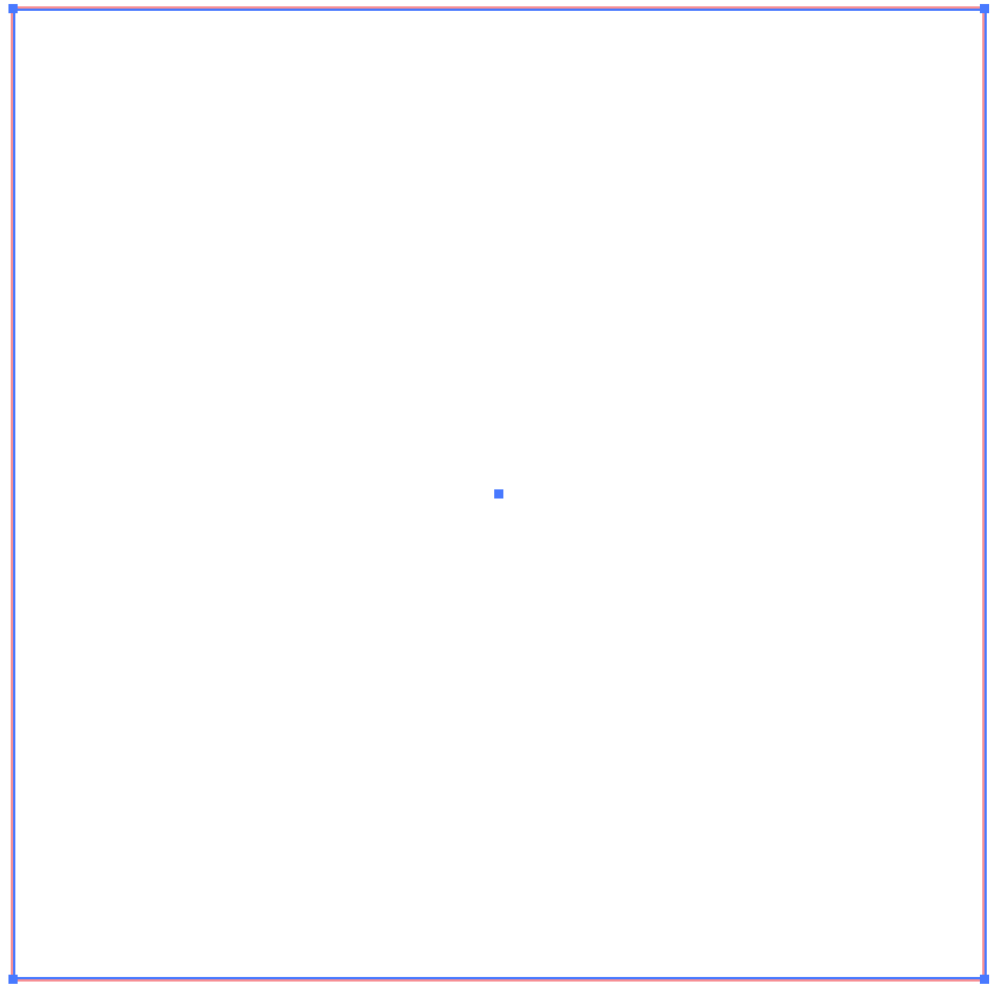
CNC Mill or Router



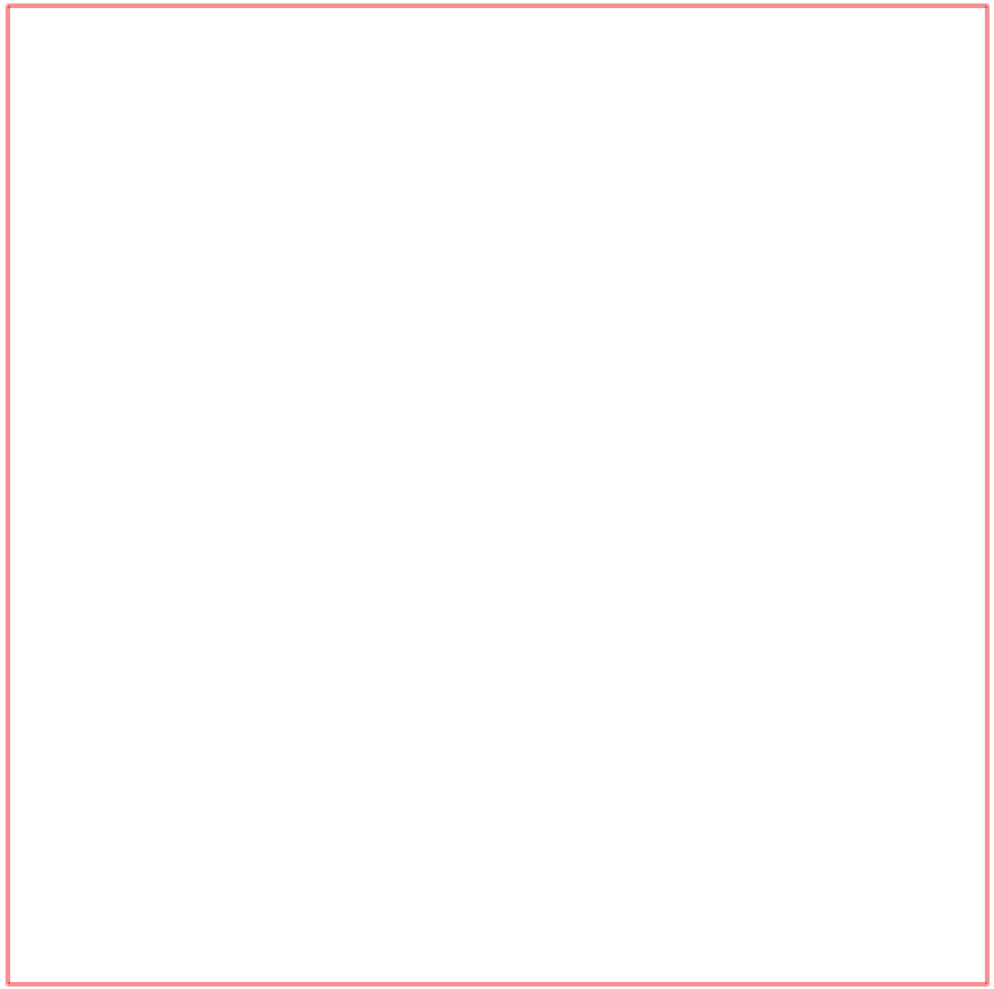
COMPUTER AIDED MANUFACTURING or **CAM** SOFTWARE LETS YOU MANIPULATE VECTOR PATHS AND THEN CONVERTS THESE PATHS INTO INSTRUCTIONS FOR YOUR MACHINE TOOL.



This is the vector path of a square.

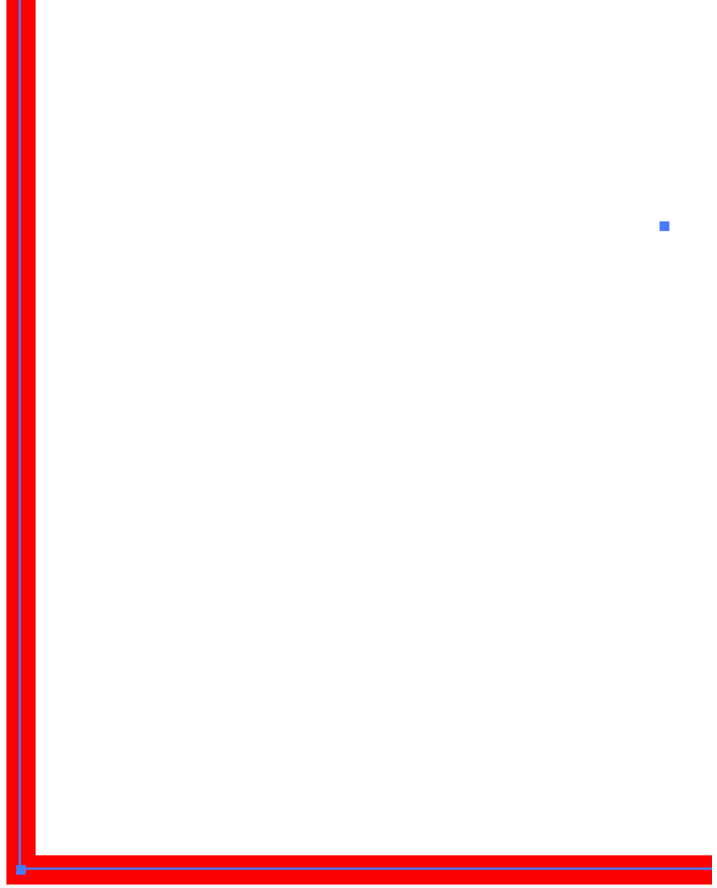


This is a vector path with a red “BORDER” (Gravit terminology) or “STROKE” (Illustrator terminology). It is also sometimes referred to as an ”OUTLINE”.

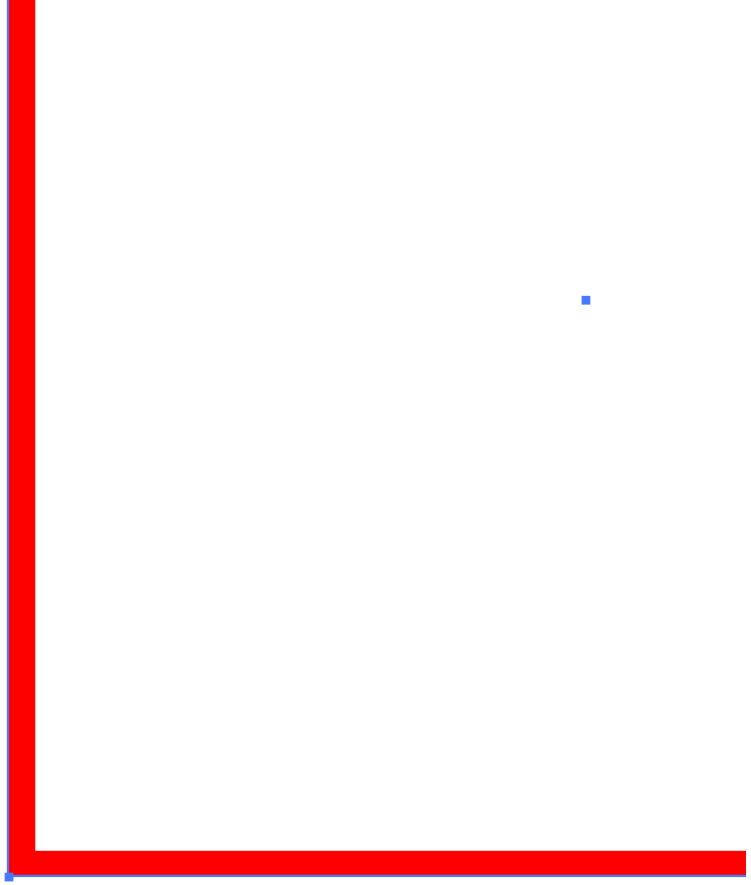


This is another look at the vector path with a red “BORDER” of “STROKE” but without the blue line of the vector highlighted. The vector line only appears when the object is selected.
Borders, strokes, or outlines, can have different thicknesses but the vector path is always the same.

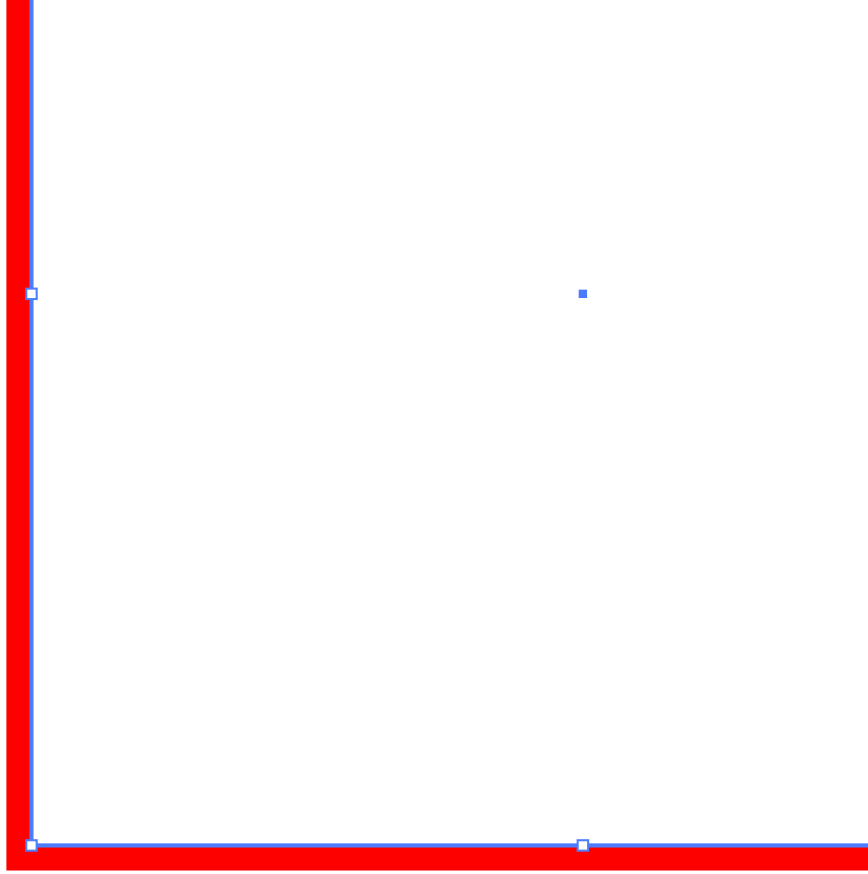
This is a close up of a vector line with a red border/stroke / outline. The blue line represents the vector path. Notice the red spills over on either side of the vector path.



middle of vector



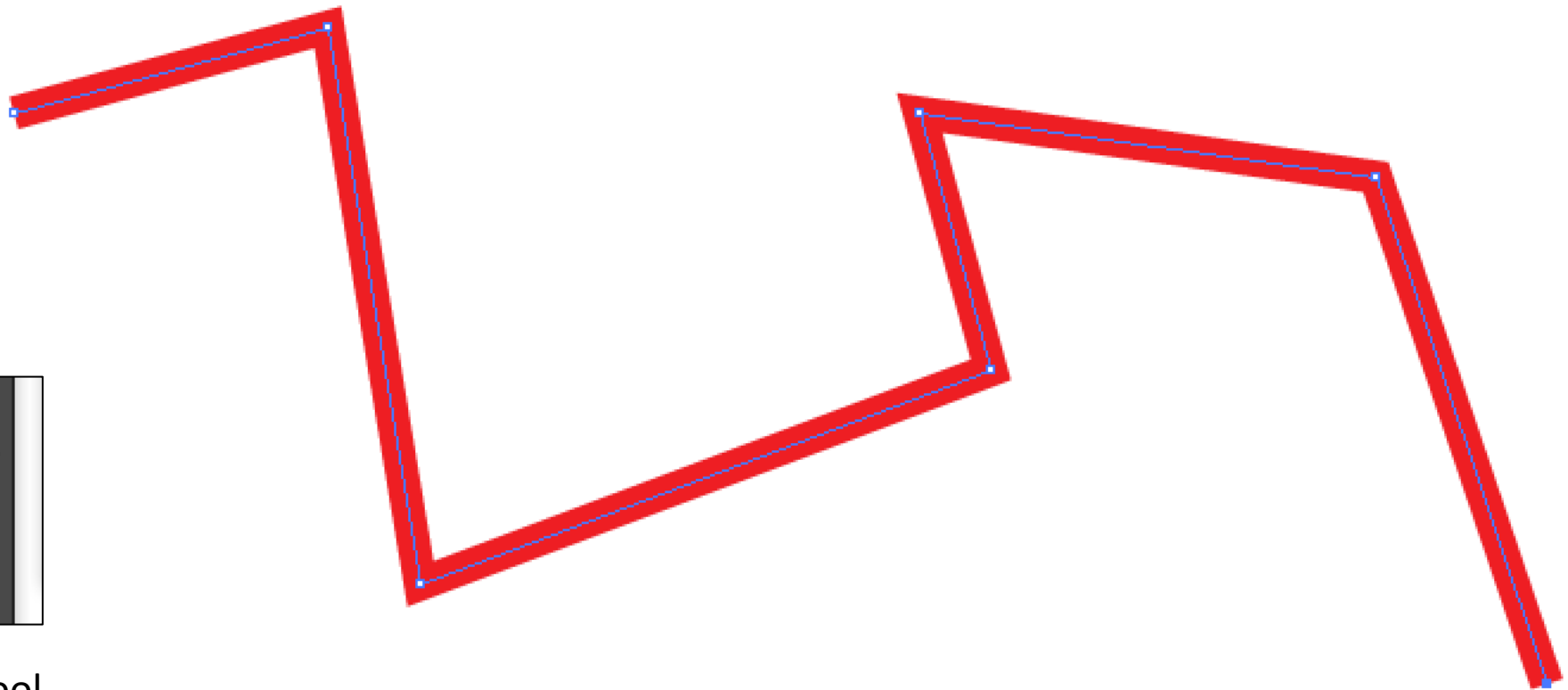
inside the vector



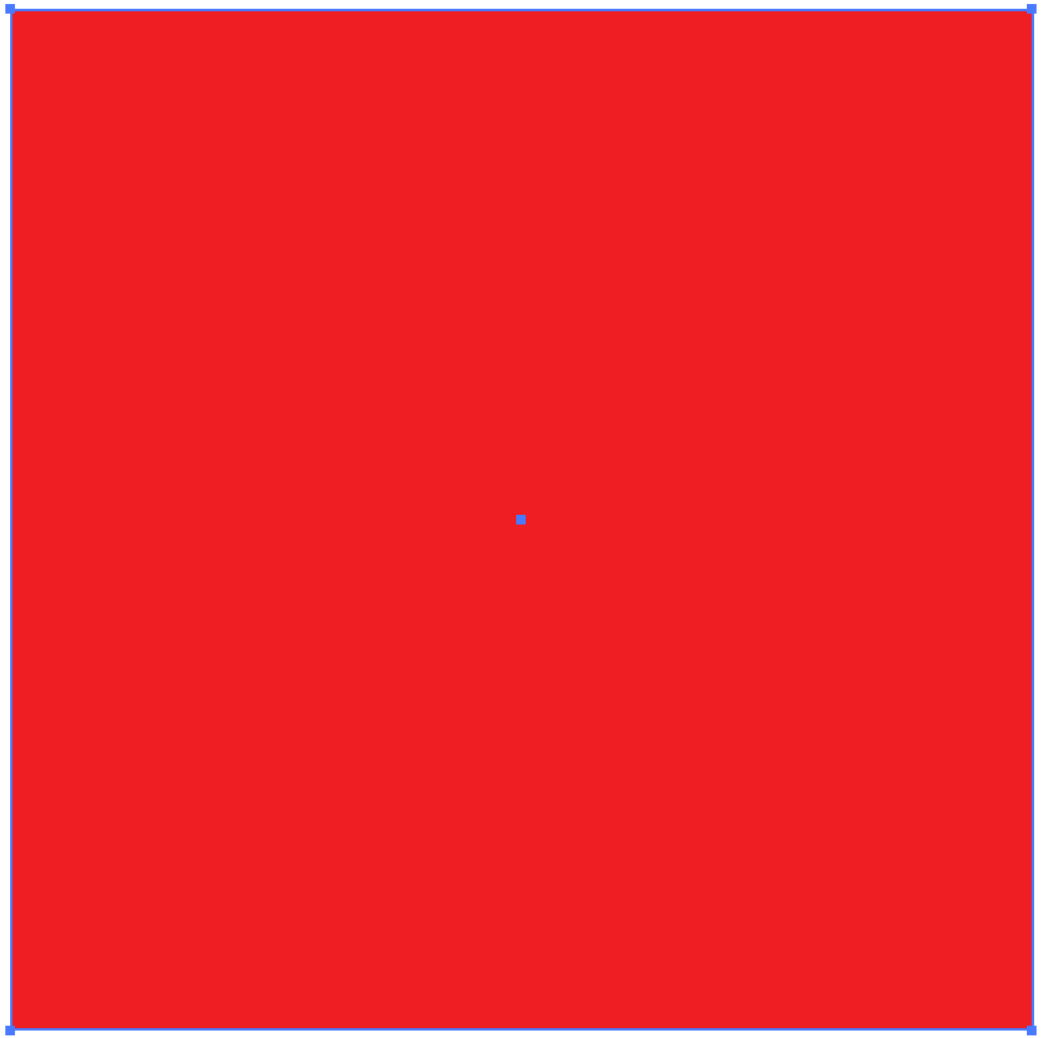
outside the vector

You can specify if a border/stroke/outline falls in the middle, on the inside, or on the outside of a vector path. This can be important in specific cases.

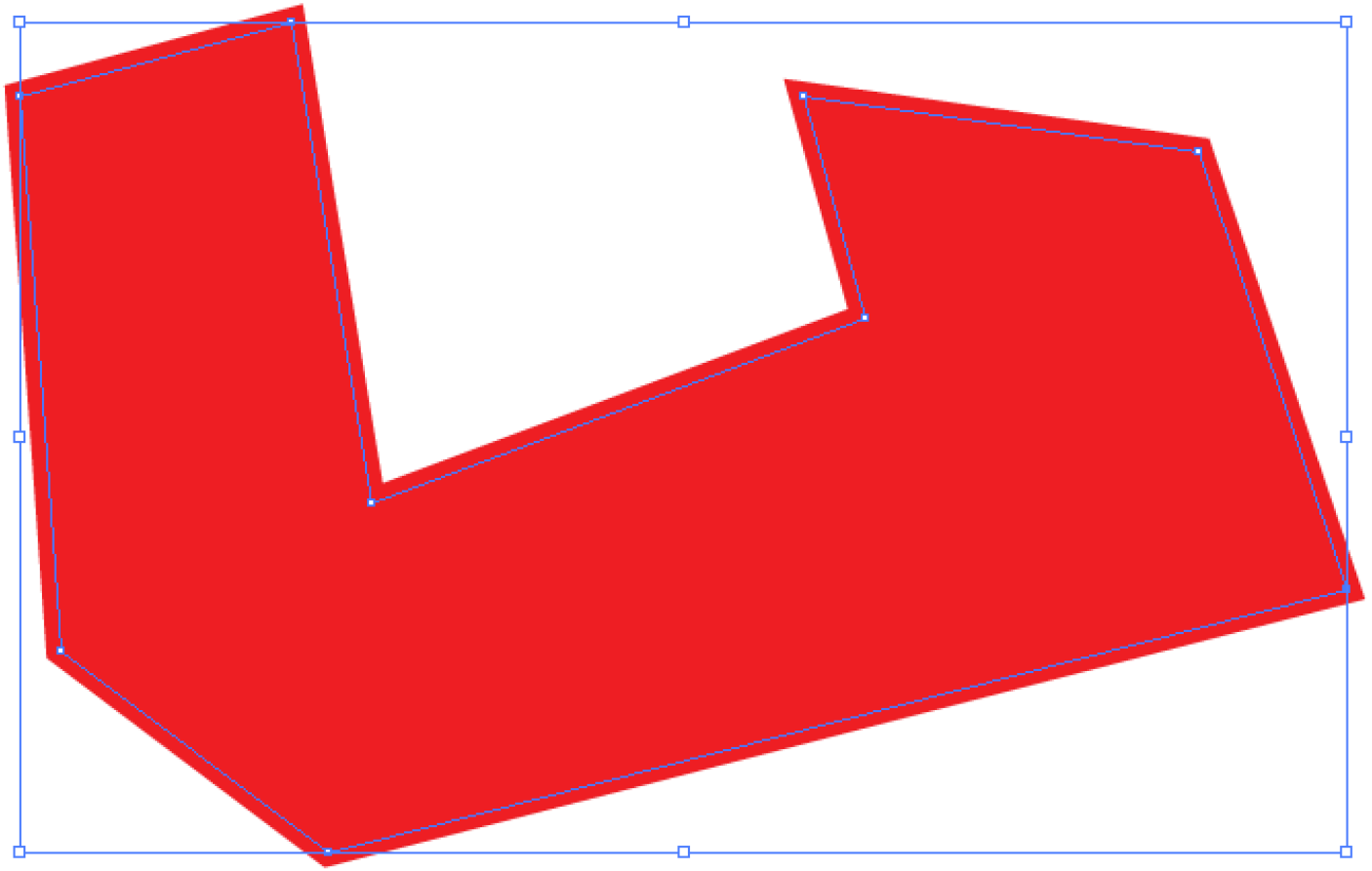
Pen Tool



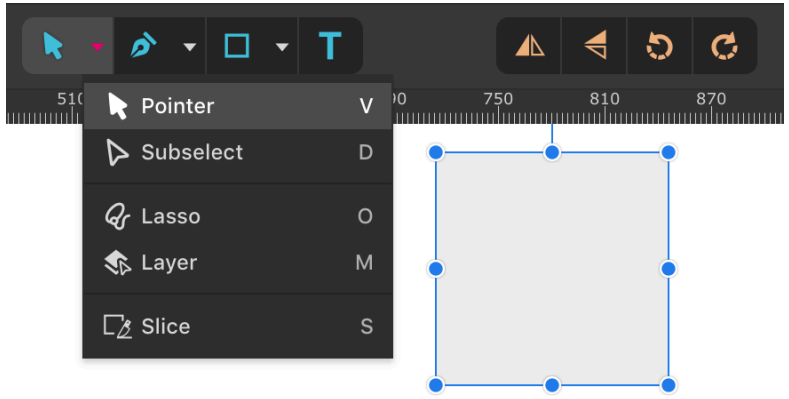
All vector software has a version of a “pen tool” which lets you draw your lines by clicking and moving.



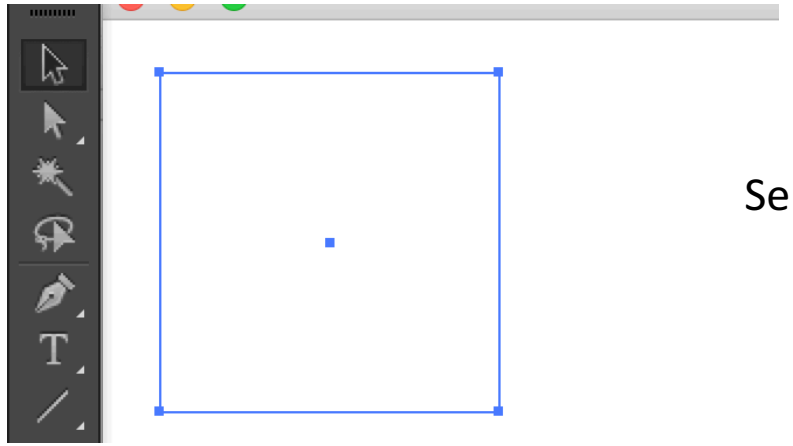
This is a vector path with a red “*FILL*”. Notice the red is filling the space between the sides of the vector path.



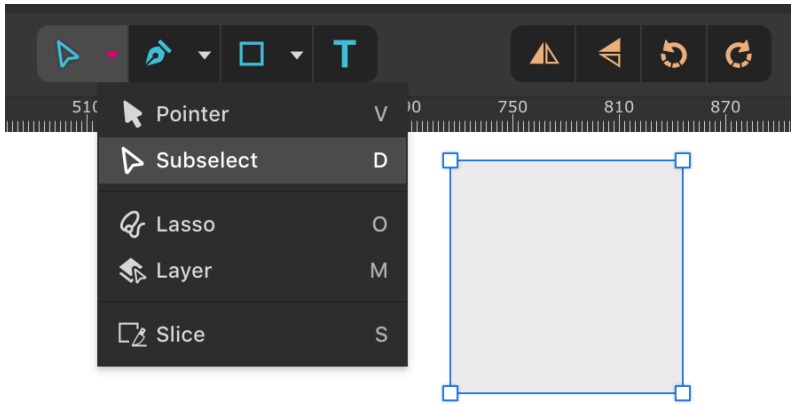
If you close a path it creates a shape.



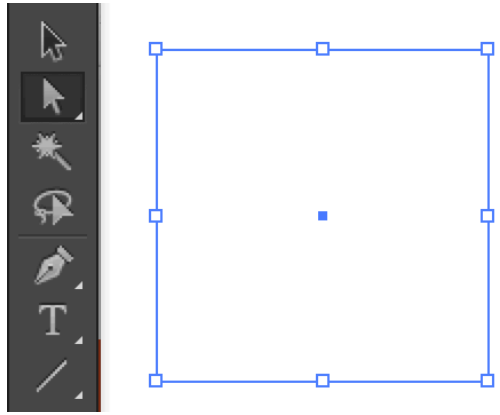
Pointer =



Selection Tool



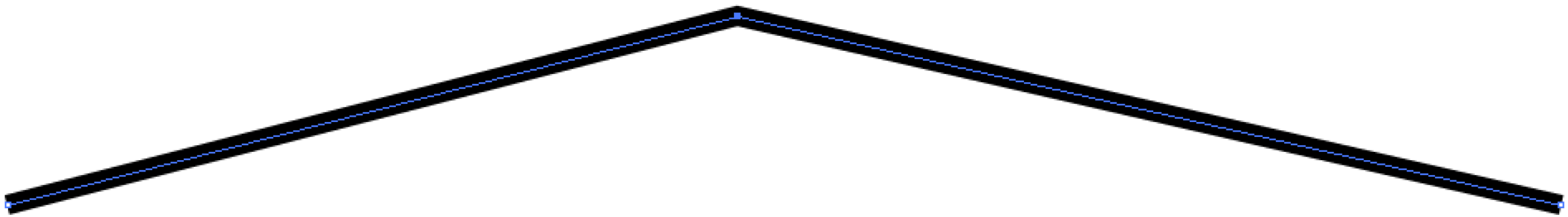
Subselect =



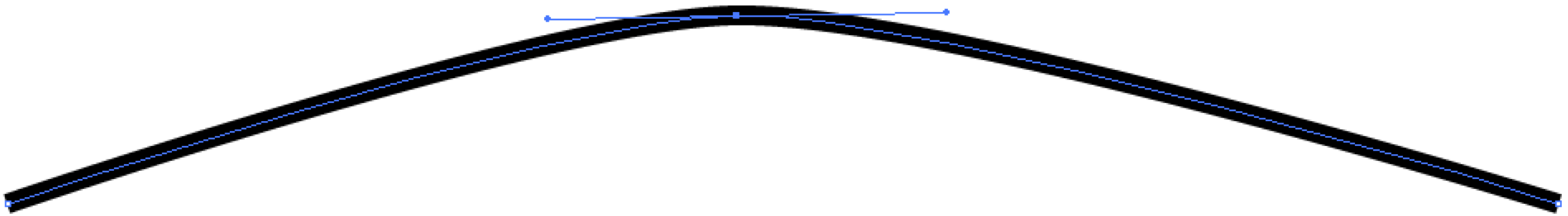
Direct Selection Tool

All vector software have two kinds of selection tools. One is to select the entire shape or path the other is to select elements within that path or shape so you can manipulate it.

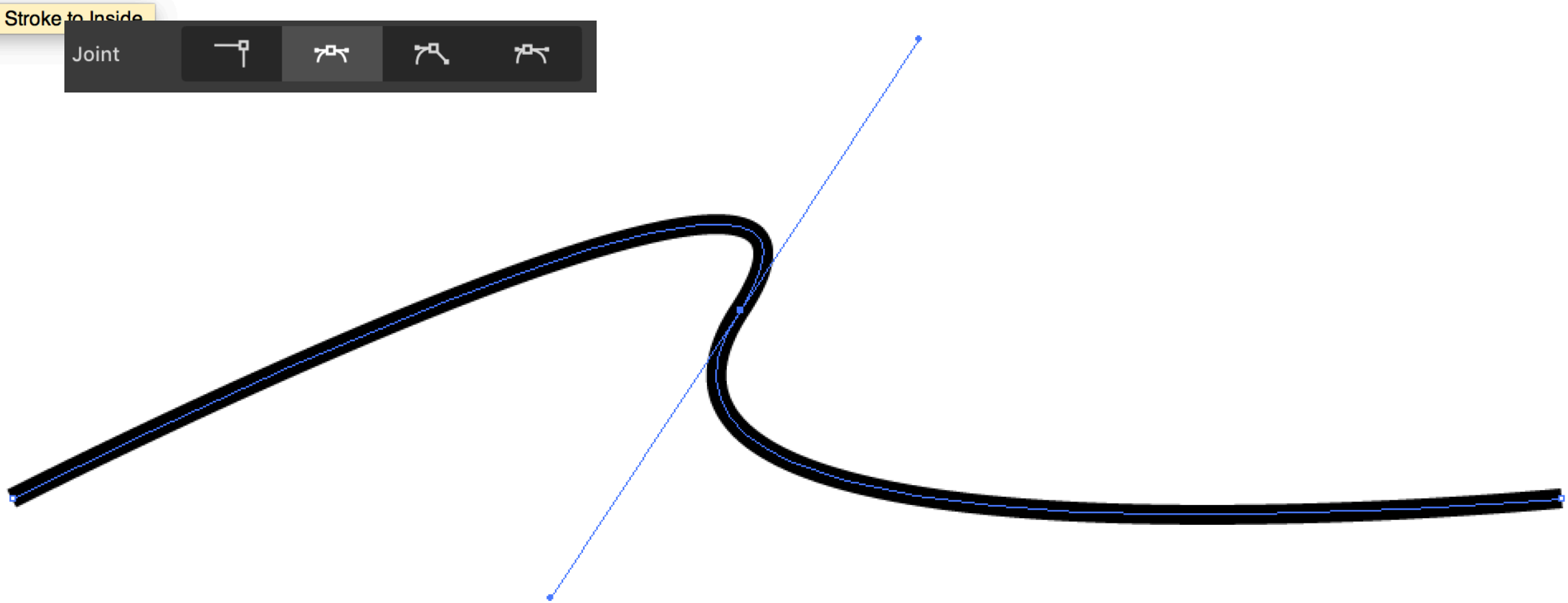
Here is a simple vector line with a black border / stroke.
Notice the three little white boxes. These are called **“nodes”** (Gravit terminology) or **“anchors”** (Illustrator terminology).



When you select a node using the ***Subselect*** tool (Gravit) or the **Direct Selection Tool** (Illustrator), it will change color (usually blue) letting you know you can now manipulate it.



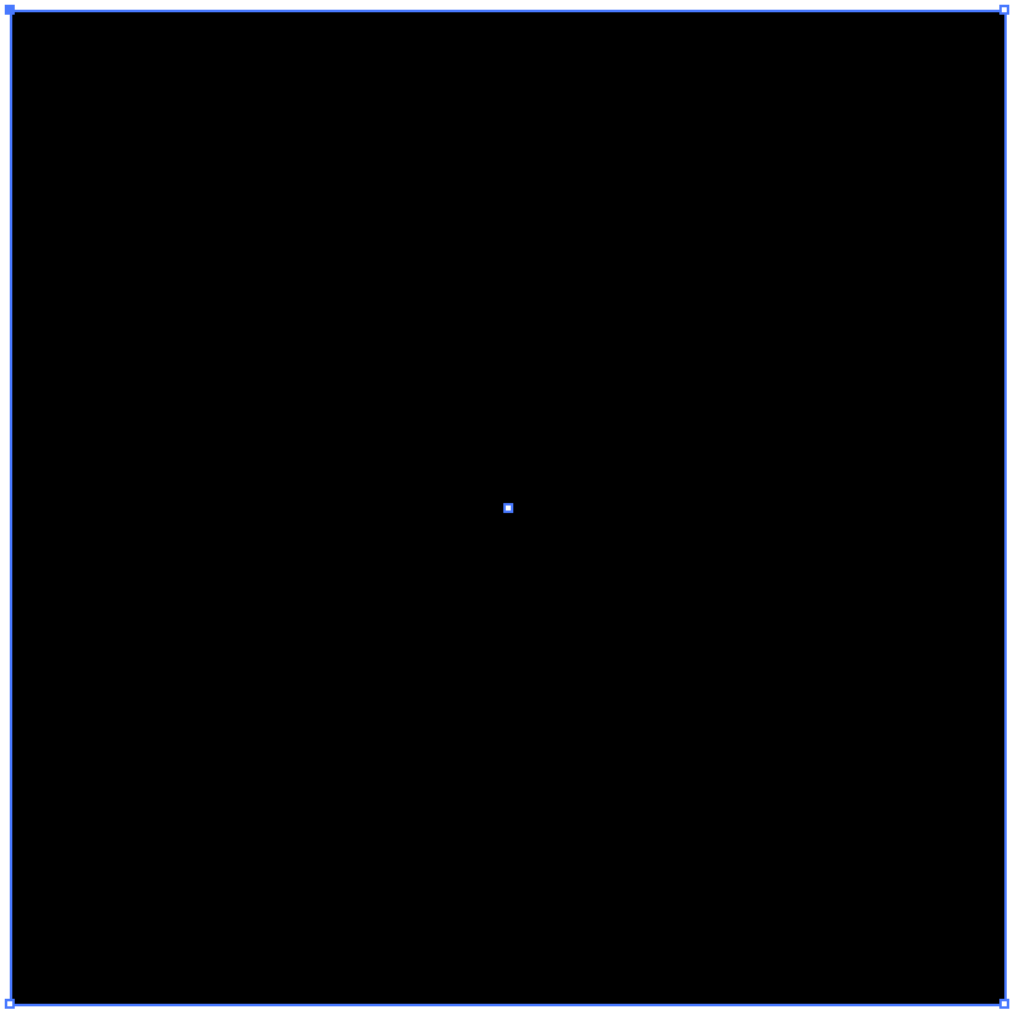
You can change the way your **node** (Gravit) or **anchor** (Illustrator) behaves. If you want to convert a sharp turn into a curve for example. When you do this you will notice two little blue lines with bumps on the end. These are called **handles** and they let you manipulate the curve of the path.



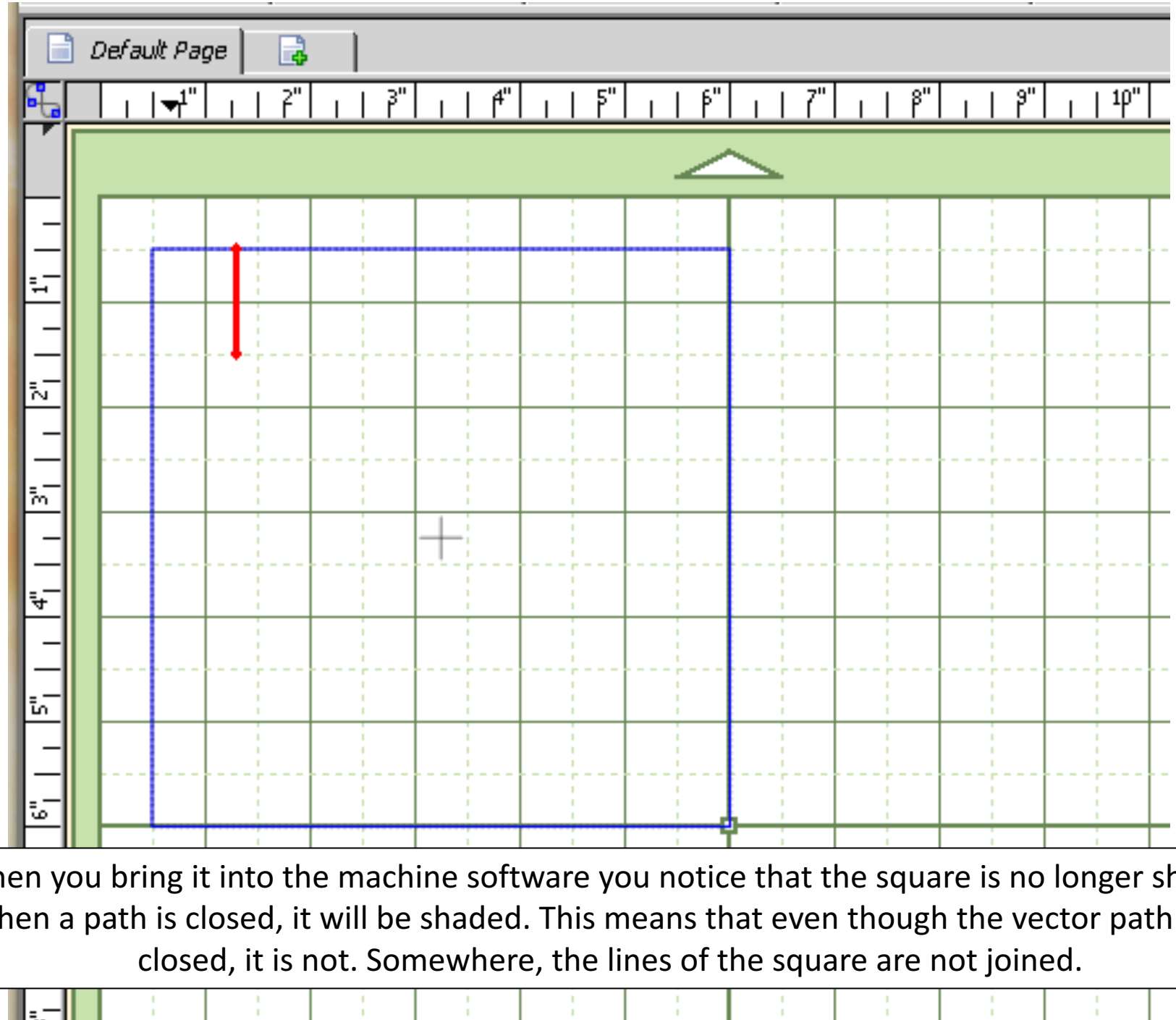
Moving the handles will change the shape of your path. This is great for creating complex curves or finessing a line to follow a specific shape.

DRAWING FOR MACHINES

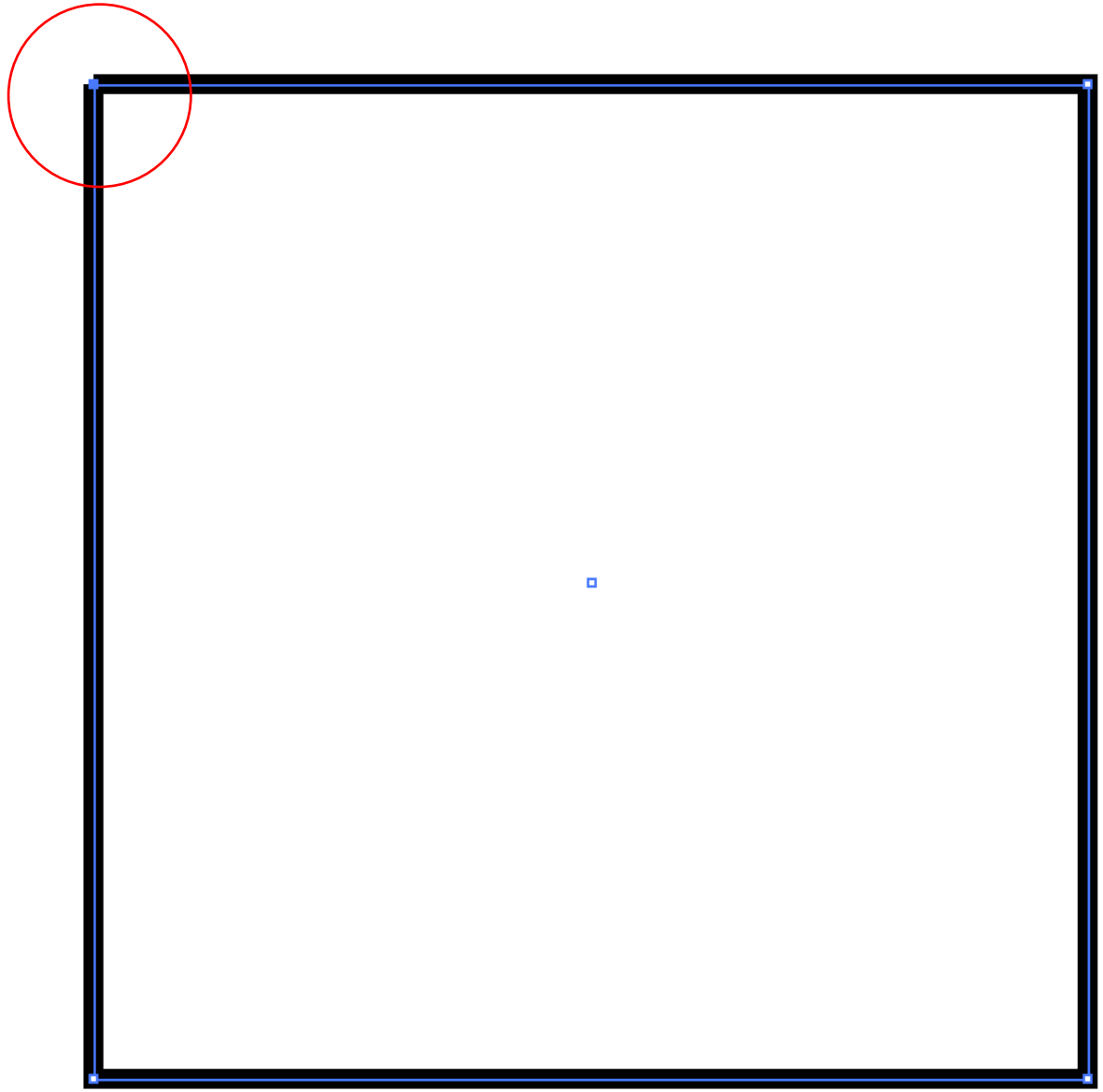
When you are drawing for CNC Machines, you need to pay attention to the details of your vector paths otherwise the machine or tool may not behave the way you want it to.



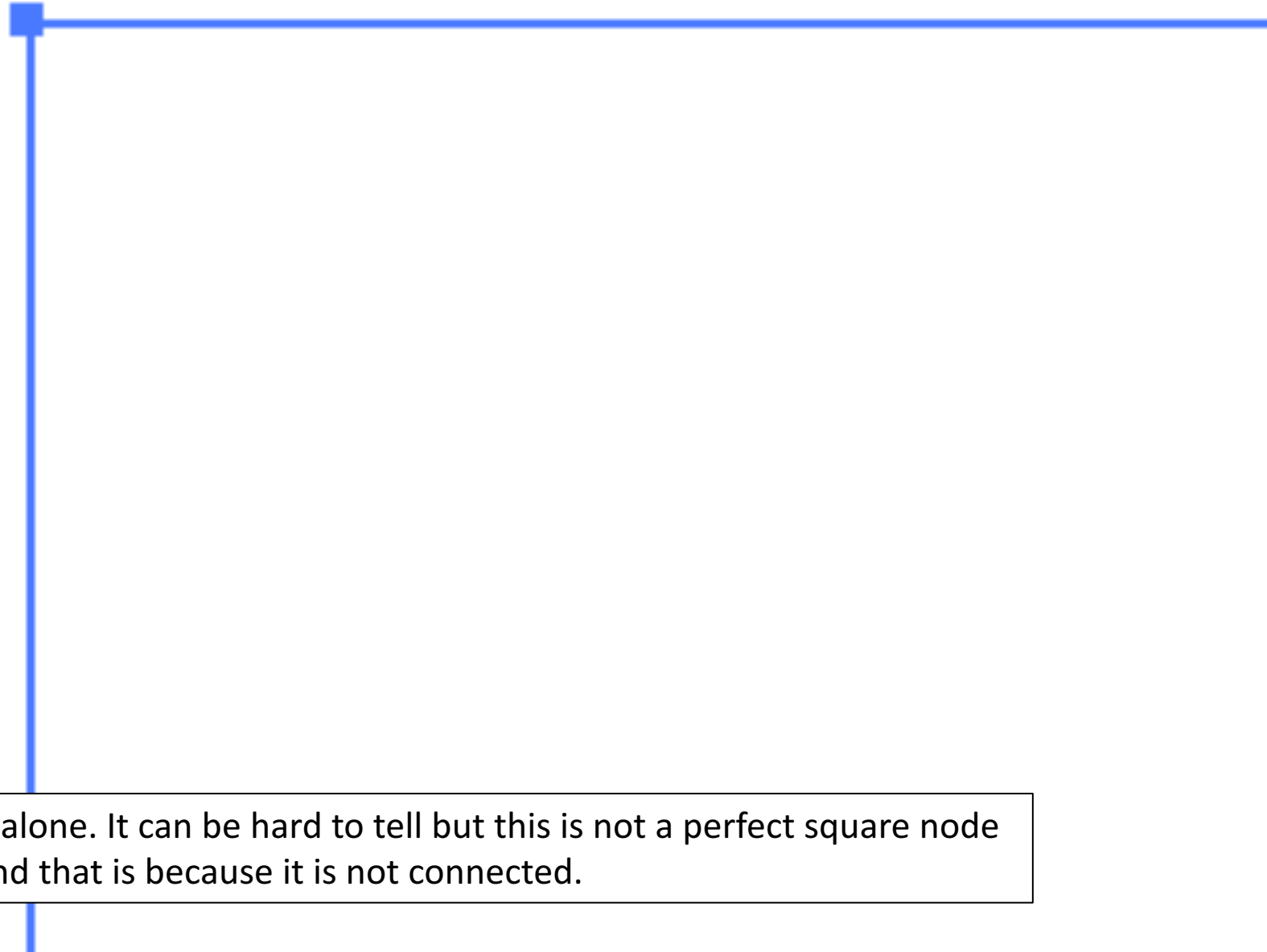
This looks like a normal square shape filled. Lets imagine you want to cut this shape out on the vinyl cutter to make a sticker.



When you bring it into the machine software you notice that the square is no longer shaded. When a path is closed, it will be shaded. This means that even though the vector path looks closed, it is not. Somewhere, the lines of the square are not joined.

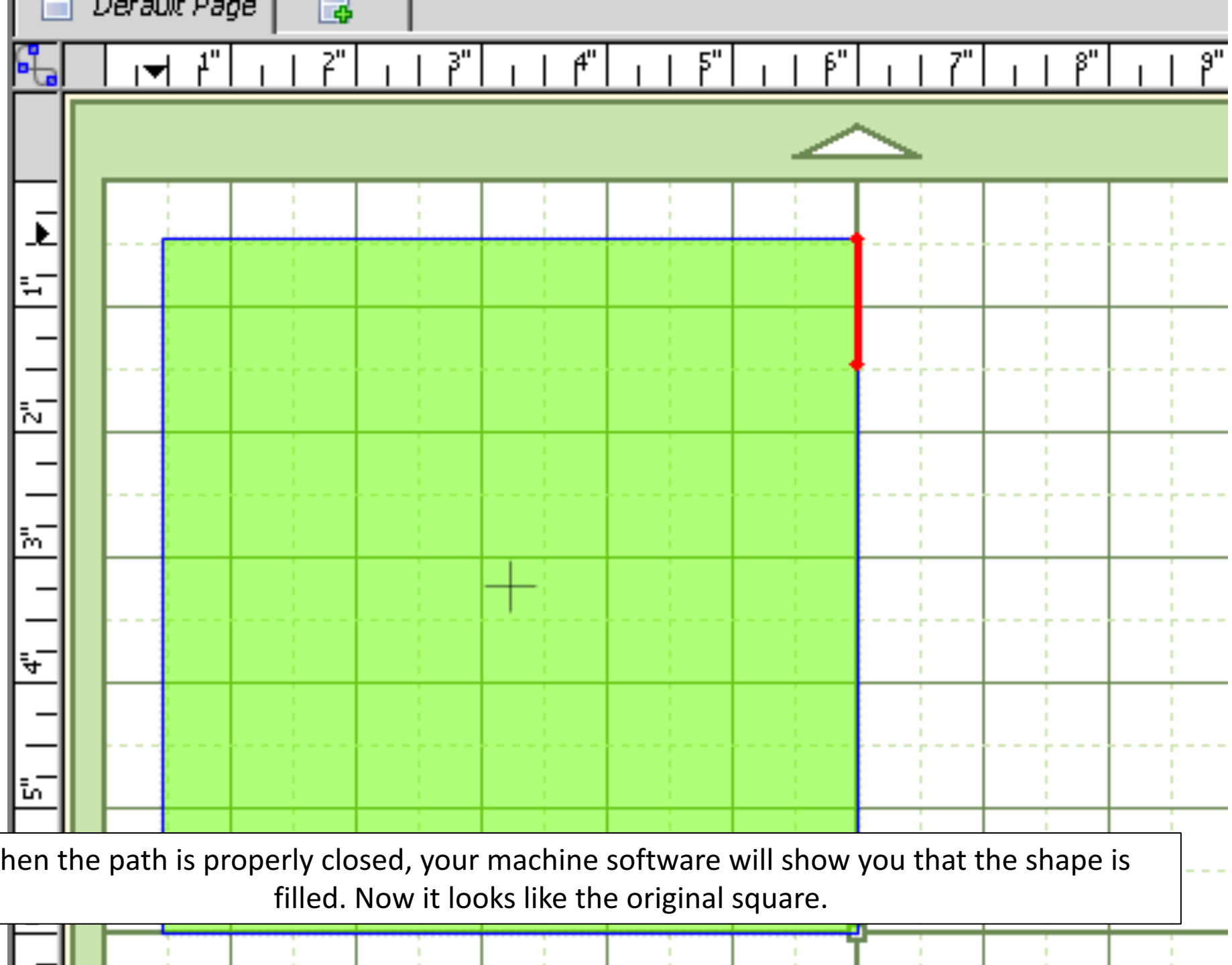


When we convert the shape to a border only you can see the problem (top left).
Notice it is not a perfect corner.

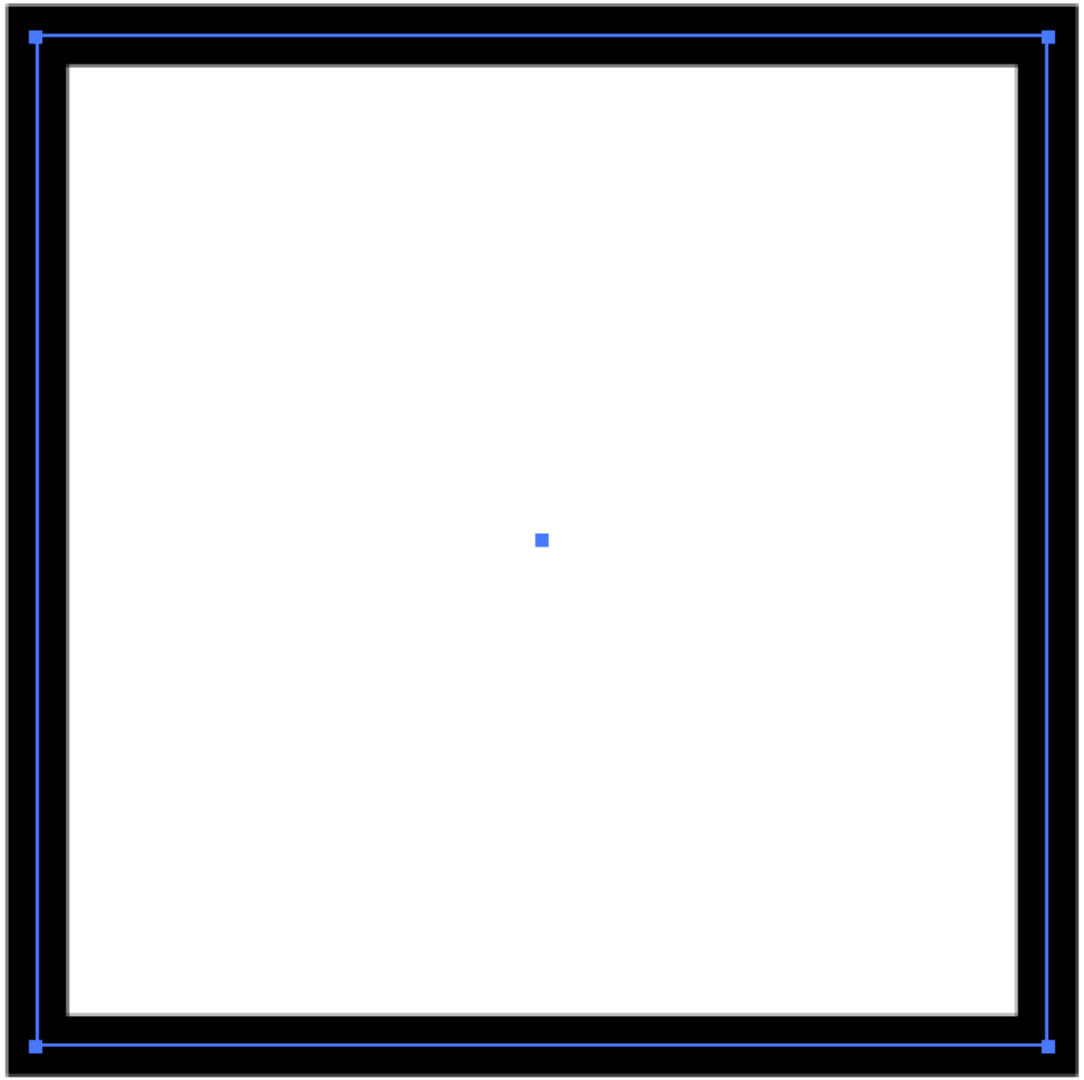


Let’s look at the vector path alone. It can be hard to tell but this is not a perfect square node and that is because it is not connected.

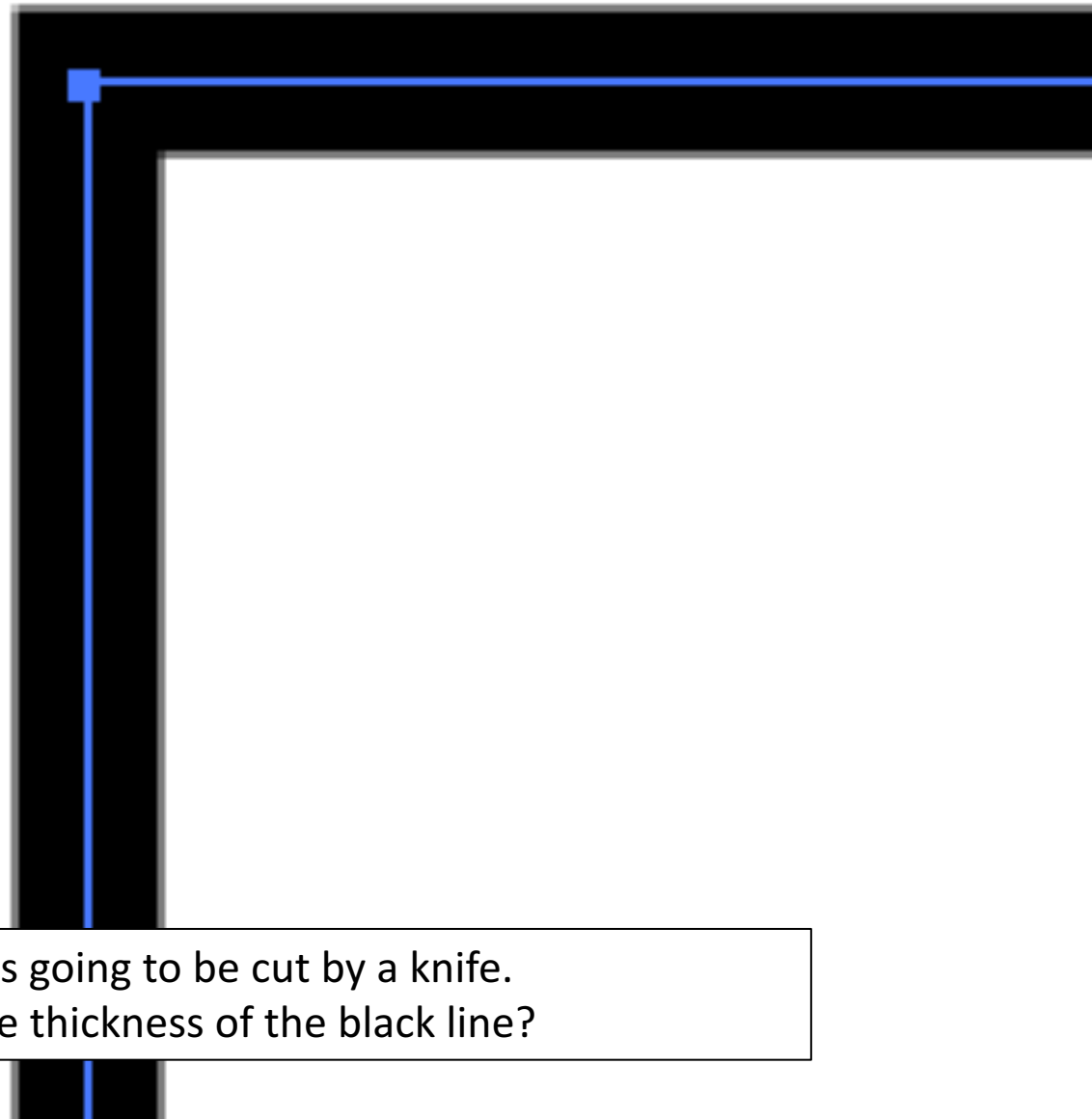
You can pull them apart. We need to connect the two together. Vector software will have a feature to join paths. This will ensure the path is properly closed.



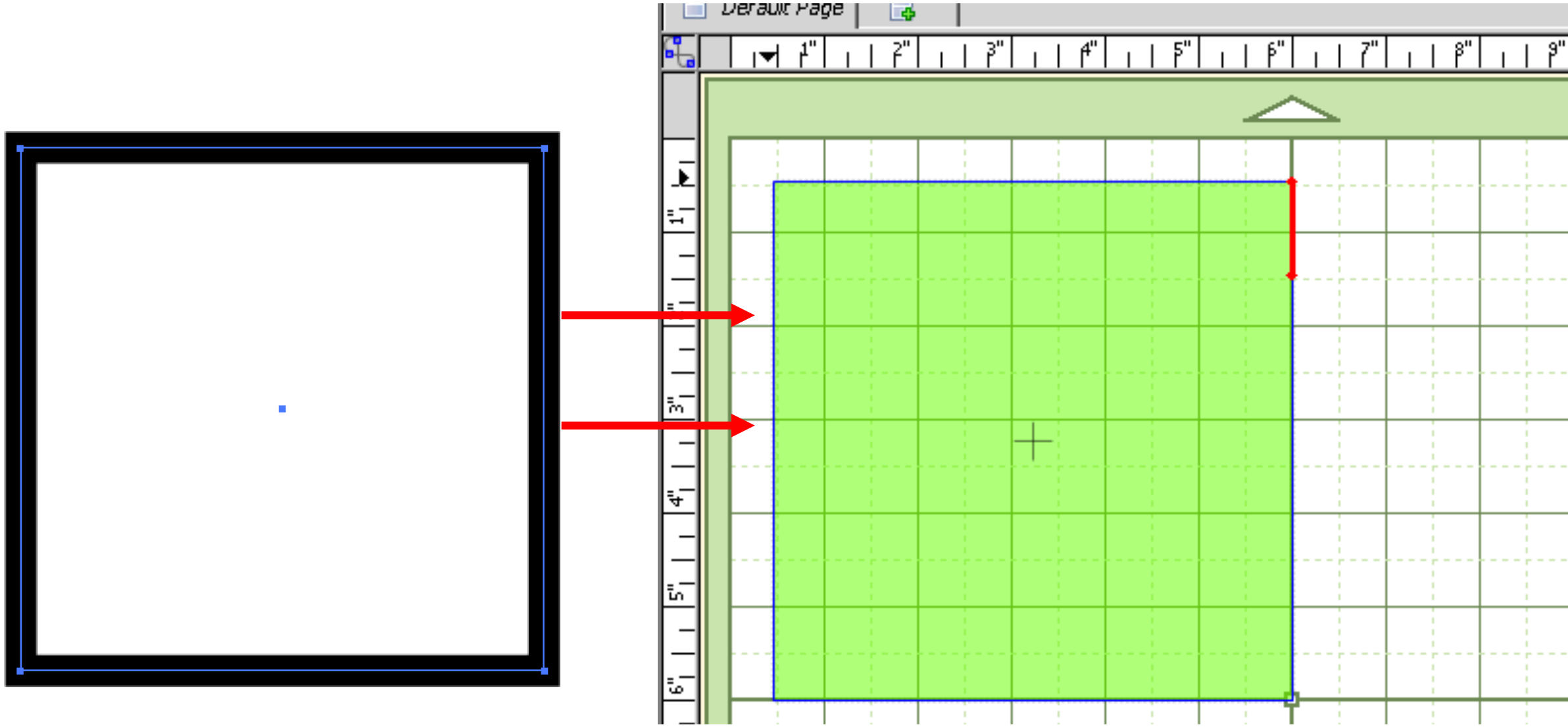
When the path is properly closed, your machine software will show you that the shape is filled. Now it looks like the original square.



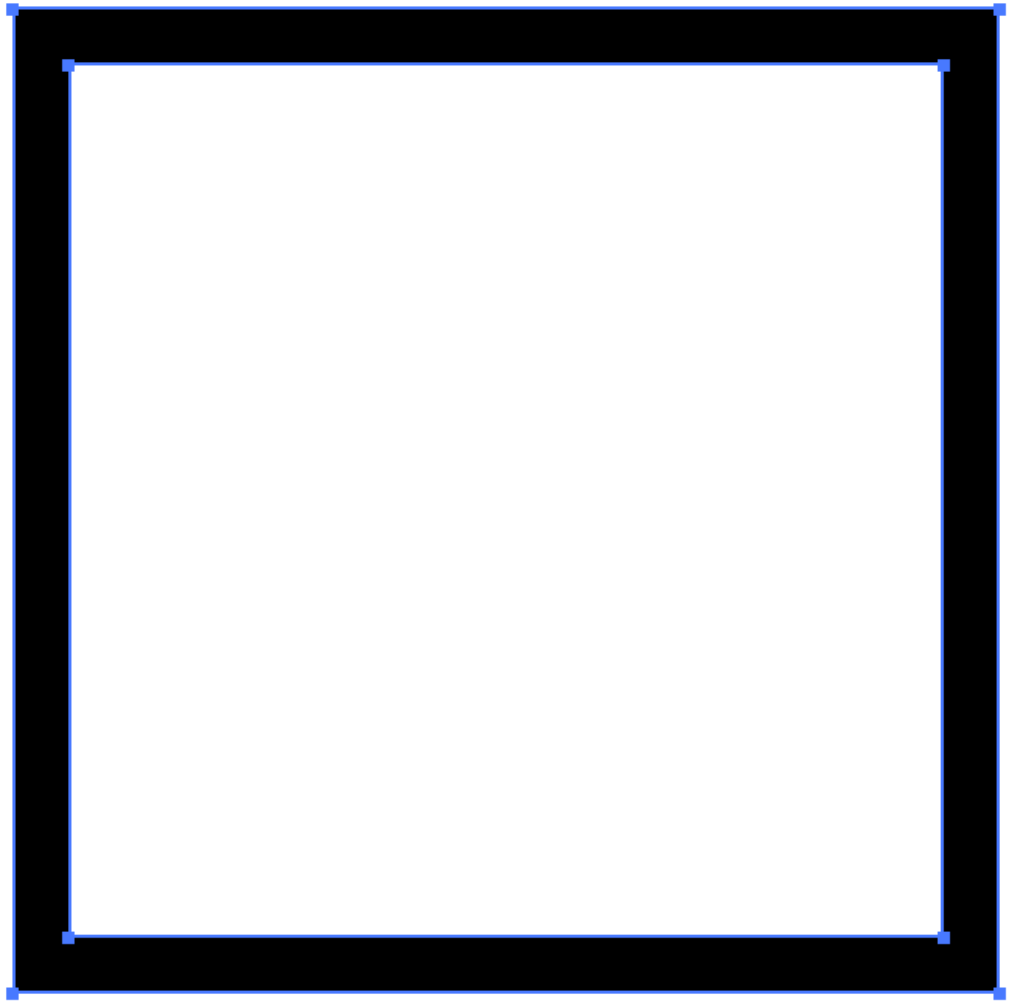
Lets say we want to cut this square frame in vinyl and the thickness of the border is the size of the frame we want.



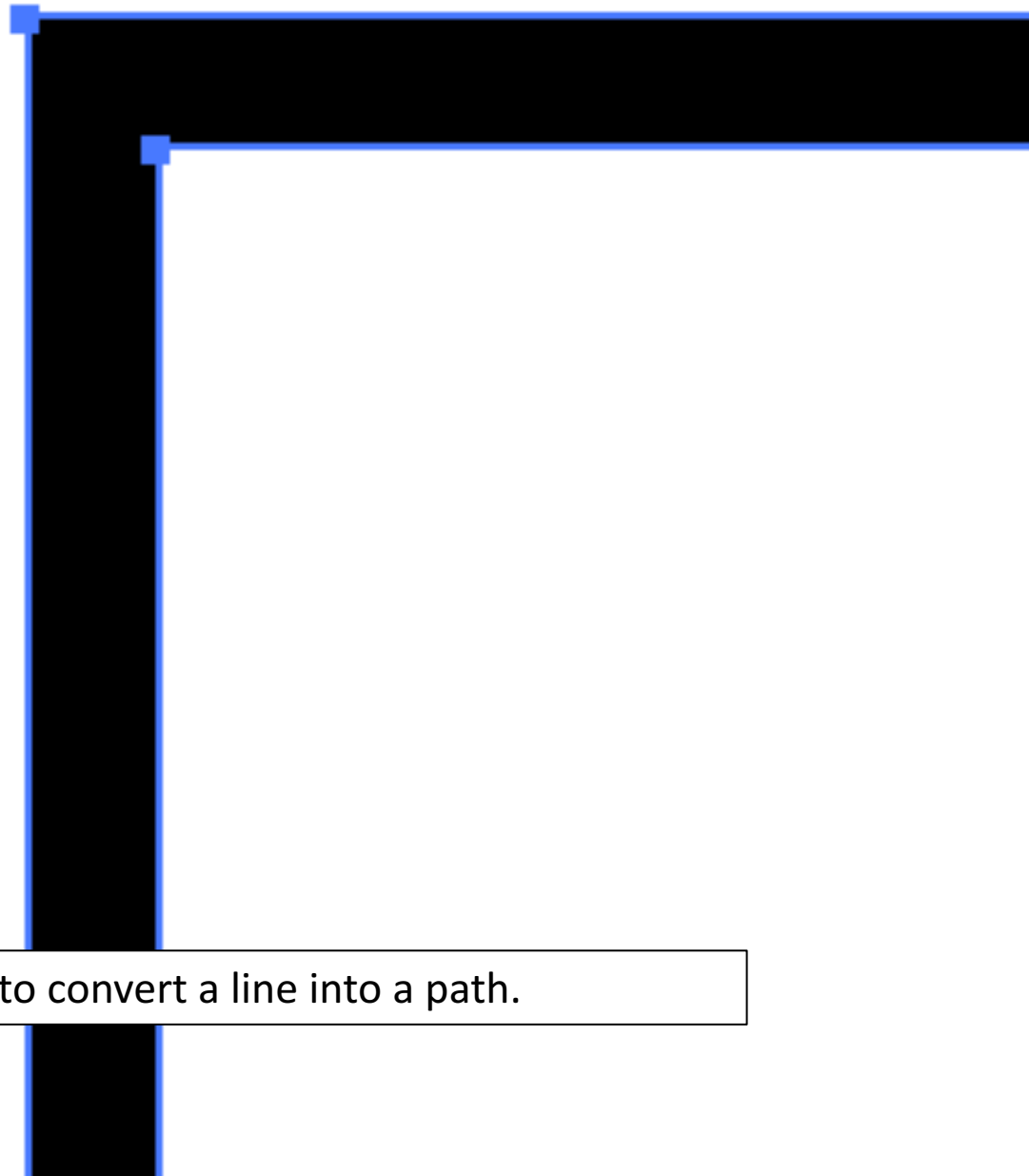
Notice the vector line and imagine it is going to be cut by a knife.
Will the knife on the vinyl cutter cut the thickness of the black line?



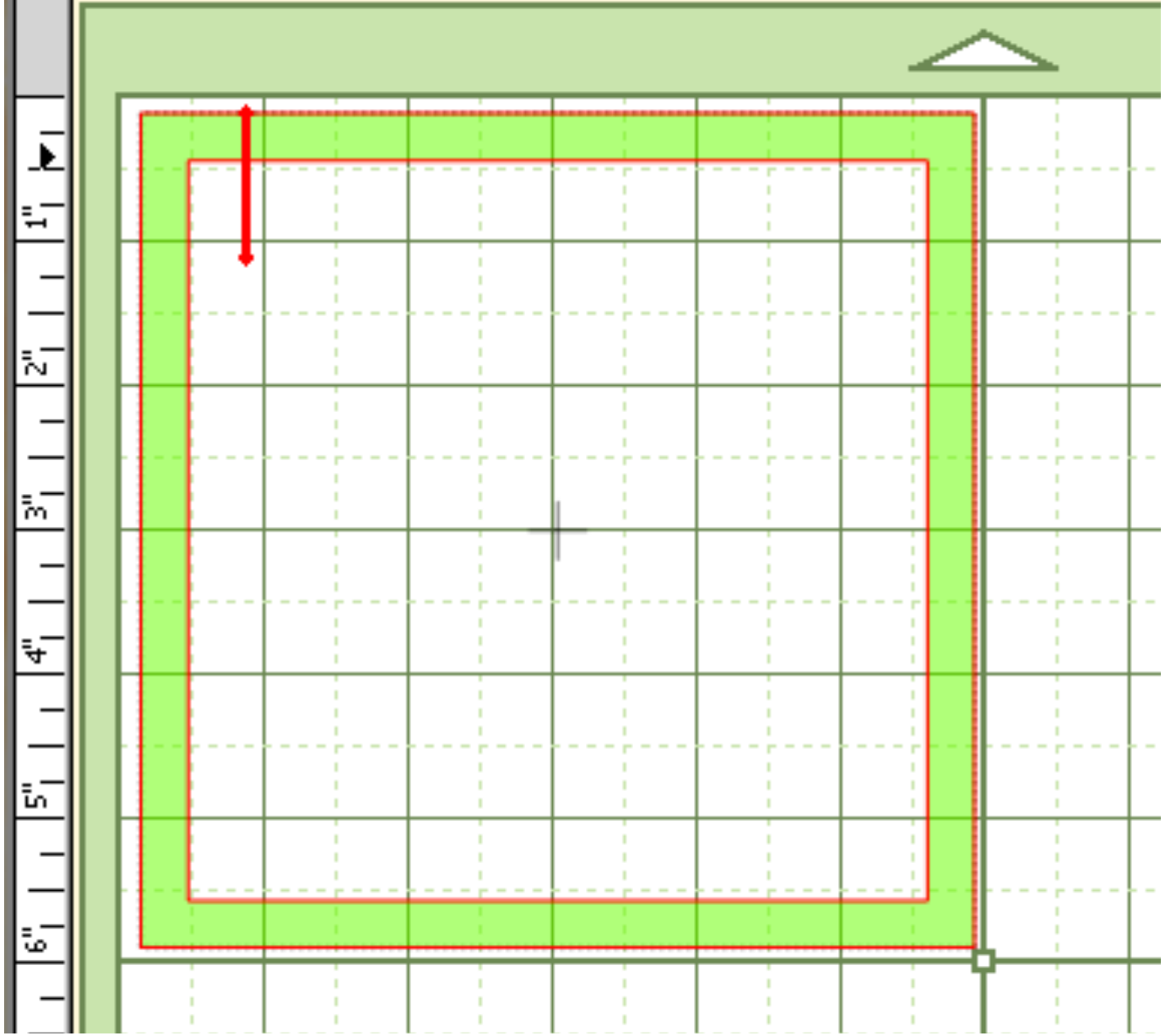
No. The machine software will look at this and see a square. Remember, we are looking at the vector path.



We need to convert the border into a ***path***. That means, we need to make sure there is a ***vector path*** on either side of the black line or border.



All good vector software will have a feature to convert a line into a path.

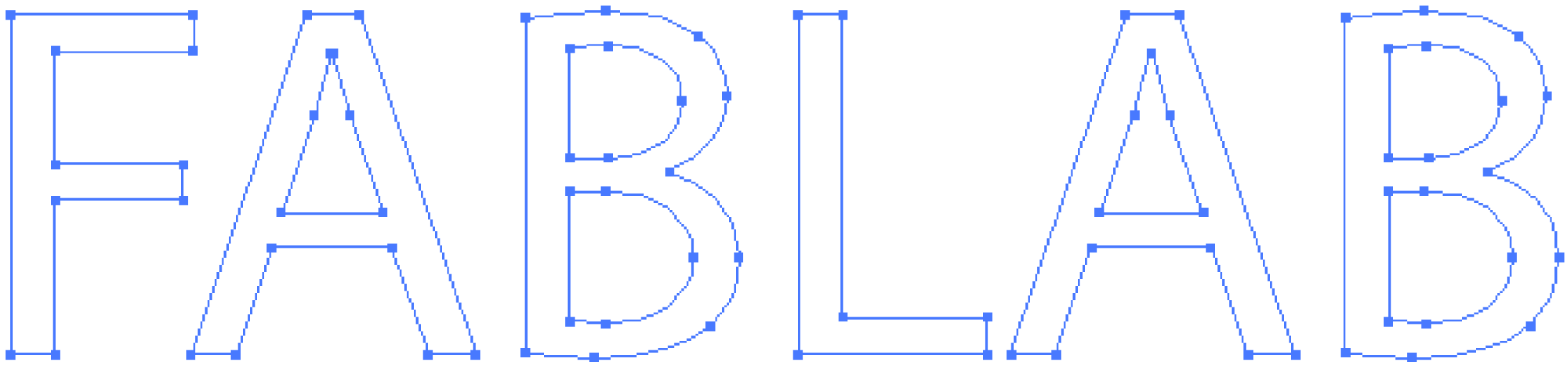


Once this is done, the machine will read the same shape.

Generating text or characters is a different computer operation. The text above is how it would appear after typing. Notice the vector line is only at the bottom demonstrating the direction of the word.

If you want a machine to follow the vector path of a word so you can cut it out of a piece of paper or some other material you need to convert the text into editable shapes by converting it to outlines or paths. Just like we did in the previous example with the square.

In this example the text has been converted to an **outline** or **path**. Now you will notice that the ***vector path*** follows the shape of the letter. Now you can imagine a knife following that path over a piece of paper to cut it out. When your text is converted to path or outlines you can no longer edit the type. You can manipulate it like any other vector shape but you can not turn an “b” to a “z” as you would normally do.



Same example but without the fill so you can see the vector path.